

7. Short listed route options

7.1 Overview of the short listed route options

The route options have been divided into the two sections of the project: Wells Crossing to the southern side of the Harwood Bridge, and Harwood Bridge to the Iluka Road intersection. This section provides a brief overview of the short listed route options in these sections. Further details of the options, and the impacts associated with them, are provided in the sections that follow.

The Wells Crossing to Iluka Road upgrade is one of only six projects for which a preferred upgrade route remains to be identified. It is part of a group of five projects that are proceeding to the route selection phase in late 2005.

This section of this report provides a brief overview of the short listed options for the section of highway between Wells Crossing and Iluka Road. The short listed options have been developed from the long list of options (described in **Section 6**) and further refined to achieve a balance between social, environmental and design parameters. As the short listed options are slightly different alignments to those on the long list, a different naming system has been adopted. The naming system is consistent with that adopted for the four other projects that are proceeding to route selection at this time, to facilitate better understanding of the Pacific Highway Upgrade Program as a whole.

7.1.1 Wells Crossing to Harwood section

Four route options have been identified in this section of the study area:

- The **Orange/A option**¹⁰, which is largely an upgrade of the existing highway to Class M standard, with the inclusion of some new sections to avoid major urban constraints.
- The **Purple/B option**, which is mostly a new route, with the exception of the northern and southern sections, which would involve upgrading of the existing highway.
- The **Green/C option**, which is entirely a new route in the east of the study area.
- The **Red/D option**, also an entirely a new route in the east of the study area.

The options have been reviewed and modified to improve their alignments, and to take into account the findings of further constraints analysis and the main issues that were identified in the long list assessment stage.

¹⁰ The Orange/A option is essentially the Brown option from the long list of route options in **Section 6**, renamed for consistency with other Pacific Highway Upgrade projects.

In addition to the four route options, two potential connections between options have been included in the assessment. These are a possible link between the Purple/B and Orange/A options in the vicinity of Tyndale and between the Red/D or Green/C options and the Purple/B option in the Shark Creek area. These connections provide increased flexibility in the selection of a preferred route for the project, by allowing combined options, consisting of sections of more than one route option. **Figure 7-1** illustrates the short list route options and potential connections.

There is a need to have some flexibility in the route option alignments, to allow for minor realignments to occur for the preferred route. For each route option a nominal alignment has been defined within a 250 metre wide corridor. The actual road reserve for the option may be anywhere within this corridor, and would be more clearly defined for the preferred route once it is selected. To enable comparative assessment of the direct impacts of the options, a nominal 100 metre wide road reserve has been identified in the centre of each option corridor. This represents an approximation of the land that would be acquired by the RTA for the project. The actual width of the acquired road reserve may vary depending on design requirements and environmental constraints. Impacts reported for each option in this section should therefore not be considered as absolute, but are provided to enable understanding of the relative impacts of each option.

7.1.2 Harwood to Iluka Road section

As discussed in **Section 6.4**, consideration was given to upgrading the existing highway to either Class A or Class M standards. Upgrading to Class A would involve duplicating the existing highway with some minor realignments to address design issues. This standard of design would allow for the highway to be used by local traffic. Access to and from the highway would be via limited at grade intersections with key local roads and a grade separated interchange at Iluka Road. Upgrading to Class A would involve a new bridge over the Clarence River adjacent to the existing Harwood Bridge.

For the purposes of assessment, upgrading to Class M has been assumed to account for the maximum extent of impacts of the project. A nominal alignment has been identified to the east of the existing alignment. As with options south of Harwood, a 100 metre wide road reserve has been assumed for the purposes of assessing direct impacts. However, the road reserve may be located anywhere within a 250 metre wide corridor defined to allow flexibility in the future development of the concept design for the project. For example, the upgrading may require relocation of the existing highway in some locations, to ensure design standards are met, or to minimise environmental impacts. It is therefore possible that direct impacts may occur both to the east and/or west of the existing highway depending on the final design of this section of the project.

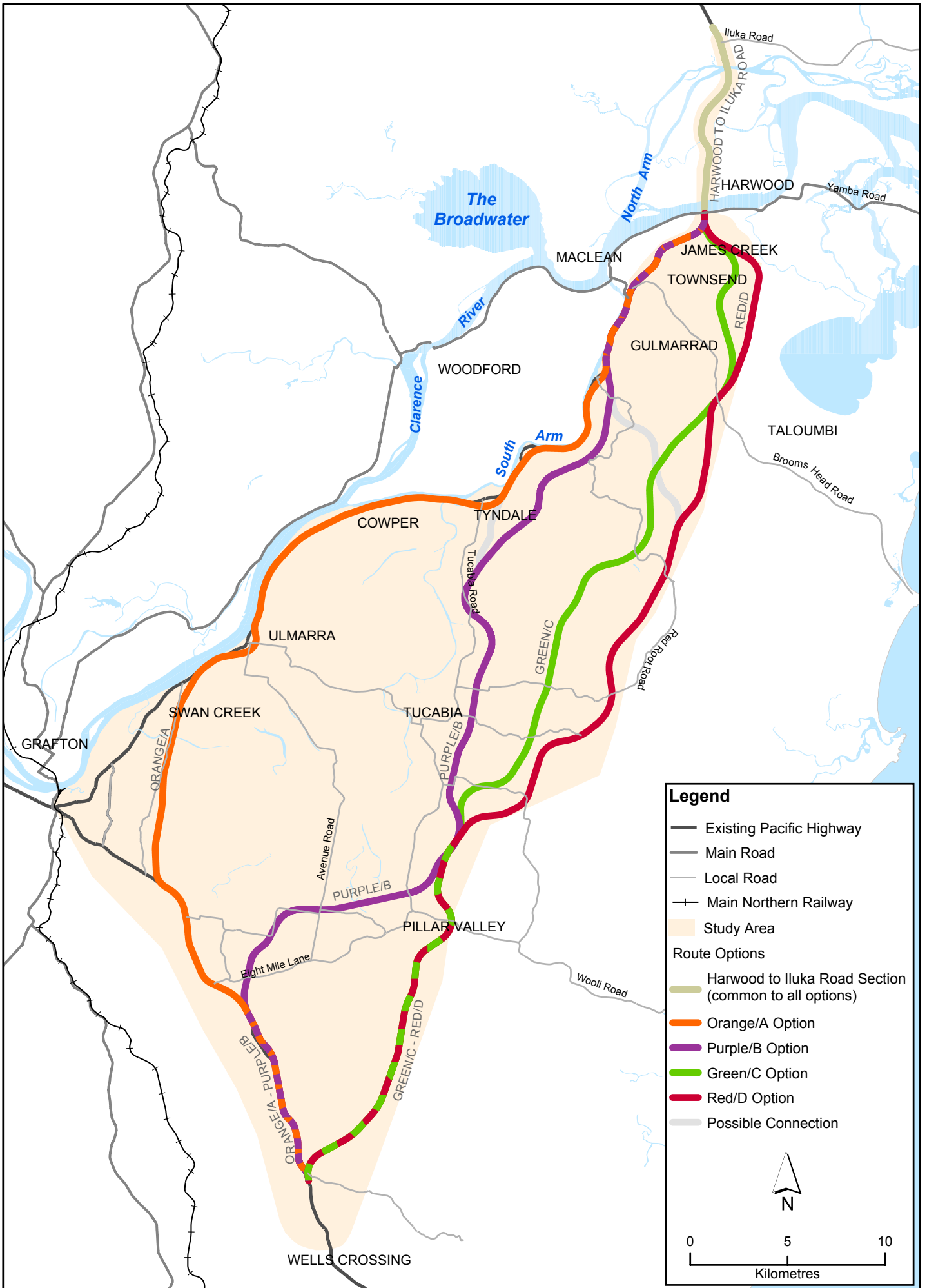


Figure 7-1 Short listed route options

Upgrading to Class M would require two new carriageways with the existing highway used as a service road to provide access to properties and towns, or as an alternative route for through traffic. Two new bridges would be required over the Clarence River, adjacent to the existing Harwood Bridge. In areas where the existing road is already dual carriageway only one additional carriageway would be required to achieve the Class M design standard. It is anticipated that one additional bridge would be required to cross the North Arm, with the existing northbound bridge used as part of the alternative route, and the existing southbound bridge converted to accommodate northbound traffic on the upgraded highway. Interchanges may be considered at intermediate locations subject to traffic demand.

As discussed in **Section 6.4**, the design of additional bridge(s) across the Clarence River will have a major impact on the design and the cost of the Harwood to Iluka Road Section of the upgrade. The major issue to be resolved is the bridge clearance height, as this directly affects the length of the bridge and its approaches.

7.1.3 Traffic and transport overview of the route options

The assessment of existing and projected future traffic and transport conditions in the study area, presented in **Section 5.2**, highlights some key characteristics of travel behaviour that are relevant to the assessment of the route options. In particular, the split between local and through traffic has significant implications for the predicted traffic volumes on a new route, and for the proportion of traffic likely to continue to use the existing Pacific Highway, for local trips. Key issues include:

- Approximately 65 per cent of all vehicles using the Pacific Highway in the study area have destinations within the study area, in particular trips between Grafton and Maclean, Iluka, Yamba and Ulmarra.
- The split of heavy vehicle trips through the study area and to destinations within the study area is approximately 50 per cent (although some heavy vehicles classed as through traffic may make short stops at destinations in the study area to pick up or drop off goods, or for rest breaks).

Generally, the route options assessed in this report can be divided into those aligned relatively close to the existing Pacific Highway, and those that are entirely new routes located away from the highway. Rather than undertake a full assessment of each of the short listed options individually, the following points are relevant to the options under consideration.

Options that closely align with the existing Pacific Highway are likely to be more attractive to local vehicle trips because travel times for local trips (for example, between Maclean and Grafton) would be reduced. An upgraded road would also be safer. For the purposes of assessing the route options, it has been assumed that options involving an upgrade of the existing highway, or a new alignment located close to the existing highway, would attract the majority of traffic that currently

uses the highway. Some traffic would continue to use the existing highway to access towns, villages, and properties that would not have easy access to the new route. The majority of heavy vehicles would be likely to use the new route in preference to the existing Pacific Highway, including local and through trip heavy vehicles. Further assignment of vehicles to the new route may be achieved through interchanges at intermediate locations along the route (if warranted by traffic demand), which would allow additional opportunities for local traffic to enter and leave the motorway.

These options would not maximise benefits for through traffic. Options aligned with the existing highway would have limited opportunities to reduce trip length and travel time for through traffic. However, through traffic would still assign to the new route as it would provide advantages over the existing Pacific Highway.

Options that are located distant from the main local destinations, in particular Grafton, are unlikely to attract substantial volumes of local traffic. This is because they would not offer travel time savings for local trips. Based on current and likely future traffic volumes in the study area, these options would be unlikely to have interchanges at intermediate locations between Wells Crossing and Harwood. Local traffic travelling between towns such as Maclean and Grafton would therefore be unlikely to use the new route. However, local traffic continuing to use the existing highway would benefit from reduced traffic volumes, separation of local traffic and through traffic, and reductions in heavy vehicle volumes.

Routes that are located distant from Grafton would provide substantial benefits for through traffic. This would include significantly reduced travel times and distances and reduced fuel costs. Based on understanding of traffic characteristics from the origin-destination survey, between 30-35 per cent of all vehicles that currently use the existing Pacific Highway are through vehicles and would be expected to assign to the new route. Approximately 50 per cent of heavy vehicles would use the new route. It is expected that the majority of large articulated heavy vehicles would use the new route. Conversely, approximately 65-70 per cent of total vehicles, and 50 per cent of all heavy vehicles, would continue to use the existing Pacific Highway. These routes would achieve the objective of separating through traffic and local traffic. However, substantial volumes of traffic would continue to use the Pacific Highway in the study area, to access local destinations.

7.1.4 Interchanges and access

Interchanges allow access to and from population centres to be maintained while allowing through safe passage for traffic, uninterrupted by delays. Interchanges would be grade-separated, consistent with the Pacific Highway Upgrade Program standards.

The strategy for determining potential interchange locations for the various route options is based on traffic and road design principles. The objectives of providing interchanges for each of the route options are to:

- Contribute to a reduction in crashes in the study area by maintaining high levels of service.
- Maximise traffic volumes on the upgraded section of highway as this will improve the economic viability of the project and provide benefits to users.
- Maintain accessibility for major population and employment centres within the study area since this will have social and economic benefits.

The project is to be developed to a motorway standard (Class M). This requires a design with no access points between interchanges along the length of the project. In some situations, the road may be developed to a Class A standard, which may include at grade intersections between the new road and local roads at limited locations along the route.

The minimum distance standard between grade-separated interchanges is about five kilometres, to allow for the required traffic weaving section lengths to be accommodated at the 110 km/hr design speeds. There is no maximum distance standard between interchanges on safety grounds.

The number of interchanges depends on access requirements to roads servicing major population centres. Whether or not an interchange is provided is determined by the predicted traffic volume requiring access to the road. 2000 vehicles per day is the generally accepted traffic volume below which grade-separation is considered uneconomic, however, the decision as to where interchanges would be provided is dependent on individual circumstances including distance and travel time for the local traffic joining or leaving the new road.

At present, access to all locations in the study area is principally via the Pacific Highway. As a minimum, access to local destinations in and around the study area would be maintained via the Pacific Highway and other local roads. Some modifications to local roads may be required to achieve the design standards of the project. However, it is a requirement of the project that standards of local access are not substantially impacted by the project.

Forecasts of traffic volumes have been assessed for the study area, as described in **Section 5.2**. These show the dominance of traffic travelling to and from Grafton. Major demand in the study area includes: between Grafton and the area south of the study area; between Grafton and Maclean/Yamba/Iluka; and through traffic. It would be advantageous in terms of maximising traffic volumes on the safer freeway to provide interchanges as close as possible to the main population centres of Grafton and the Maclean area. Yamba, which lies south of the river, could be served from an interchange near Maclean.

There are several smaller centres spread throughout the study area which do not generate large volumes of traffic, but where local accessibility may potentially be affected by some options. These include towns on the highway such as Ulmarra, Cowper and Tyndale; inland towns and localities such as Pillar Valley and Tucabia; and coastal villages such as Minnie Water, Wooli and Brooms Head. It is important that access to these locations be maintained but this would not necessarily be via grade-separated interchanges.

Eastern route options are likely to cross Wooli Road and Brooms Head Road as well as minor access roads through farmland and State forest. The more westerly options could potentially cross additional roads such as Coldstream Road. The viability of providing interchanges at these locations would be the subject of more detailed traffic assessment, and would depend on anticipated population growth and the degree of diversion required if no interchange were to be provided. However, the current and 2021 forecast traffic volumes on Wooli Road and Brooms Head Road do not in themselves warrant grade-separated interchanges with the new road. Access to and from the existing Pacific Highway would be maintained by underpasses or overpasses.

The assessment of individual route options in the following sections includes descriptions of potential interchange locations for each option. As a general principle, interchanges are currently being considered south of Grafton where each option diverts from the existing highway, and in the area between Maclean and Harwood Bridge. An interchange would also be provided at Iluka Road.

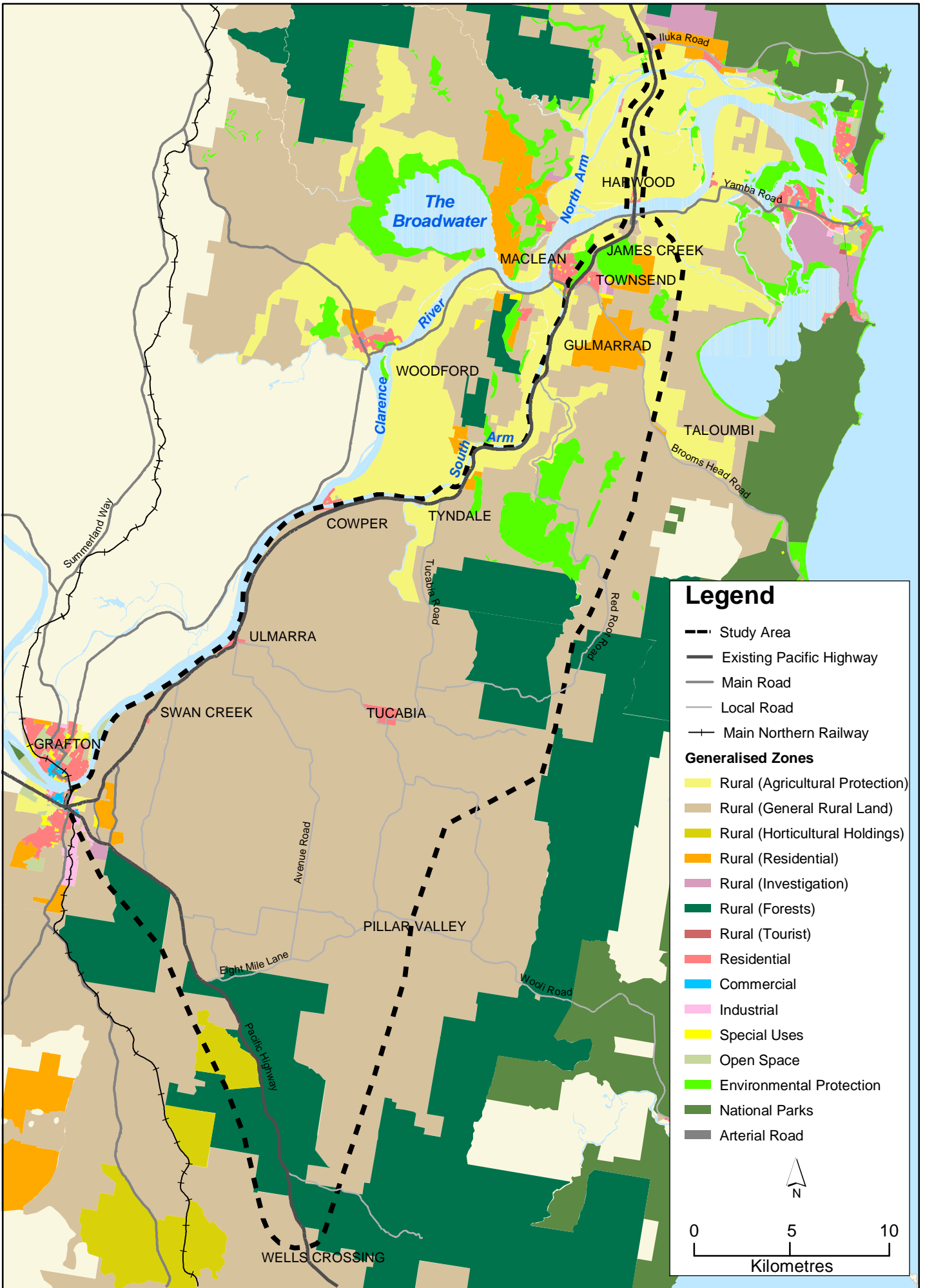
7.1.5 Statutory planning overview of the route options

Clarence Valley Council is an amalgamation of three council areas and planning controls have yet to be consolidated. The following controls continue to apply to the study area:

- Grafton LEP 1988.
- Maclean LEP 2001.
- Ulmarra LEP 1992.

Figure 7-2 illustrates the generalised land use zoning within the study area, based on amalgamation of similar zones from the above LEPs.

The route options are all located within the Maclean and Ulmarra LEP areas. None of the options impacts on land zoned under Grafton LEP 1988. In the case of Maclean LEP 2001, the project would be defined as either a 'road' or 'public utility undertaking', both of which are permissible with consent under all zones in Maclean LEP with the exception of zone 8(a) National Parks, where roads are prohibited. Within all zones except 8(a) (and within SEPP 14 wetlands, or where heritage items or heritage conservation areas are impacted), the proposal would be permissible without consent through the provisions of SEPP 4. Maclean LEP 2001 adopts the Model Provisions.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 7-2 Generalised zoning under Ulmarra, Grafton and Maclean LEPS

However, the Model Provisions would not apply to remove the prohibition within the 8(a) zone, because any proposal to upgrade the highway would involve either widening of the existing road or the formation or alteration of a means of access to a road. Further, requirements to obtain development consent within SEPP 14 wetlands or where heritage items or heritage conservation areas are affected may remain.

Planning action may be required for approval of an option within the 8(a) zone, SEPP 14 wetlands or heritage conservation areas. Any option that impacts on a national park would require an Act of Parliament to amend the national park boundary.

The provisions of Ulmarra LEP 1992 confer discretionary powers on council to determine whether developments are permissible with consent or prohibited in all zones, based on consistency with the zone objectives. Only preliminary discussions have been held with council to date on this issue, and no formal opinion has been provided by Clarence Valley Council as to whether the route options assessed in this report are consistent with the zone objectives. Further consultation will be undertaken with council in relation to this matter during the display of the route options.

The recent introduction of Part 3A of the EP&A Act may affect the approval process for the project. The Minister for Planning has declared that Part 3A applies to all projects for which the proponent is also the determining authority and which otherwise would have required an EIS to be obtained under Part 5 of the EP&A Act. If it is established that Part 5 of the EP&A Act applies to the project, and in the event that it is determined by the RTA that an EIS would be required, it would be subject to Part 3A. If an EIS is not required the project would be subject to environmental assessment by way of a Review of Environmental Factors prepared in accordance with Part 5 of the EP&A Act.

7.2 Assessment of the Orange/A option

7.2.1 Overview

The Orange/A option is the most western of the options under consideration. It is predominantly a new motorway adjacent to the existing Pacific Highway. The existing highway would be retained as a local access road and alternative route to the upgraded highway. The Orange/A option includes an easterly deviation to avoid South Grafton, between Bom Bom State Forest and Swan Creek. It also includes a bypass of Ulmarra (following the route of the previously approved Ulmarra Bypass), and a deviation at Tyndale to avoid flooding and soft soils to the west and north of the town.

The Orange/A option is the longest option, at 69 kilometres long, and crosses 38 kilometres of flood plain, more than any other option. Bridges would be provided at Swan Creek, Coldstream River, Shark Creek and other minor creeks. The preliminary cost of the Orange/A option is between \$1300 and \$1400 million in 2005 dollars.

7.2.2 Traffic and transport considerations

Traffic volumes, travel time and costs

This option offers opportunities for staged construction. Because it would be located in close proximity to the existing highway, it would potentially be possible to develop sections of the new route over time, or to develop the road initially to Class A standard with full upgrade to Class M at a later stage. Potential staging may provide economic benefits to the project.

The Orange/A option (which is closely aligned with the existing highway) would provide benefits to local traffic and through traffic. Depending on the locations of interchanges, the majority of traffic that currently uses the highway would be expected to utilise the Orange/A option. Subject to the location of accesses and interchanges, it would be likely to attract all through traffic and a high proportion of local traffic.

The Orange/A option would achieve a relatively small reduction in the length of the Pacific Highway, being approximately three kilometres shorter than the existing highway, and would not achieve the same opportunities for travel time and construction cost savings as other options. The estimated travel time for through traffic on the Orange/A option (assuming a constant speed of 110 km/h) between Wells Crossing and Harwood is approximately 37 minutes. The approximate travel time reduction for through traffic would be eight minutes. Travel time savings would be largely attributable to the higher speed at which vehicles could travel on the Orange/A option compared to the existing highway, rather than reduction in distance.

The Orange/A option is relatively flat, with all gradients anticipated to be below the maximum standards set by the RTA.

Safety

As with all the route options under assessment, the Orange/A option would be designed to achieve the safety standards set by the RTA, and would achieve the target crash rate of 15 accidents per 100 MVKT. As a further benefit, the Orange/A option would also be expected to result in a substantial reduction in the number of accidents on the existing Pacific Highway commensurate with the large volume of traffic that would be removed from it. Overall, for traffic using the new route and the Pacific Highway, the accident rate in the corridor within the study area would be expected to reduce by approximately 50 per cent.

Relationship to the local road network

Where the Orange/A option is closely aligned with the existing Pacific Highway, two new carriageways would be constructed, and the existing highway would be used as a local access road. The new highway would be a Class M standard road, and access to and from it would be via interchanges with major local roads only.

The Orange/A option has the potential to result in substantial changes to local access patterns, as direct highway access will no longer be available. A system of local service roads would be required to provide access to the properties and local roads that currently intersect directly with the highway.

Between Wells Crossing and South Grafton, direct property access to the existing highway is limited. A single service road (possibly using the existing highway alignment) would be constructed along the length of the new alignment to provide access to individual properties and local roads such as Eight Mile Lane and Bald Knob Road. Where access is required to the opposite side of the upgraded highway, bridges would be provided either over or under the new alignment. Crossing points would be rationalised by use of additional service roads (on the opposite side of the upgrade to the main service road) or by upgrading alternative routes where practical and appropriate.

Between South Grafton and Swan Creek, there will be little impact on local access via the existing highway. North of Swan Creek, a more substantial system of service roads would be required to ensure access is maintained to local roads and properties, as well as townships such as Ulmarra, Tyndale and Cowper. This may require service roads to be provided on both sides of the upgraded highway in some sections, or for the service road to cross over or under the upgraded highway at a number of locations.

Along the existing bypass of Maclean between Ferry Park and Harwood Bridge there are very few properties that rely on direct access to the highway, and limited connections between the highway and local roads. Despite this, an alternative route would be provided through this section to avoid the need for local traffic to divert through Maclean.

Interchanges with the existing highway would be considered east of Four Mile Lane and north of Swan Creek to provide access to and from Grafton. Further analysis of traffic conditions is required to determine the need for a partial interchange south of Maclean. Another interchange south of the Harwood Bridge would be considered to provide access to Maclean and Yamba. The location of interchanges would be subject to further analysis of travel demand in and around the study area.

7.2.3 Environmental considerations

Topography, geology and soils

South of Grafton, the Orange/A option is located in Southern Shale Lowlands soil landscapes, which are well suited to the construction of roads. Materials from cuttings would be of reasonable quality, but likely to be unsuitable for select fill. Through this section the likelihood of encountering acid sulphate soils is low.

From Grafton through to Tyndale, the Orange/A option crosses Clarence River Floodplain soils. Significant amounts of imported fill would be needed in order to achieve the required flood immunity. Soil conditions are likely to present difficulties of soft foundations and potentially high settlement rates that would require either a long period of pre-loading or alternative treatments, such as installation of wick drains, to accelerate the process. The location of the Orange/A option adjacent to the existing highway would result in better ground conditions than exist further east in the floodplain as there are better quality levee soils near the river margins. The potential for acid sulphate soils through the Clarence River floodplain is high, however, this would not greatly effect construction as the road would be predominantly on fill, with the exception of bridge foundations, which would require special design measures.

North of Tyndale, the Orange/A option is located predominantly on Clarence River Floodplain and Clarence River Delta soils. A small section, east of Maclean, is within the Eastern Hills and Valley terrain unit. The Clarence River Delta soils are similar to the Clarence River Floodplain soils described above in relation to the suitability for construction. The Eastern Hills and Valley soils present reasonable construction conditions although some seams may be difficult to rip. Materials from cuttings would be of reasonable quality, although they are not expected to be suitable for select fill. The likelihood of acid sulphate soils through the Eastern Hills and Valley soils is low.

Drainage and flooding

The Orange/A option passes through the Clarence River floodplain for a distance of approximately 38 kilometres, substantially longer than for any other option. Although the existing highway is located on a levee, considerable sections of the alignment would need to be raised in order to achieve the required flood immunity. This would require a significant amount of fill to be brought in from either quarries near the site or from other sections of the highway upgrade that have a surplus of materials. Road embankments across the floodplain would be typically two to three metres high, but up to six metres high in some locations.

Numerous structures would be required to provide adequate capacity to pass floodwaters without adversely affecting the flood levels or duration. In designing the flooding requirements, a maximum increase in flood levels of 50 mm would be adopted. To achieve this approximately 20-25 floodway bridge structures would be required, some up to hundreds of metres long, as well as ten bridges over creeks out of the floodplain. In addition, numerous culvert crossings would also be required. Bridges and other structures contribute substantially to the high cost estimate for this option.

Water quality

The Orange/A option traverses the catchments of a number of tributaries of the Clarence River, and would require crossings at Bom Bom Creek, Swan Creek, Coldstream River and Shark Creek. A significant length of the proposed option is adjacent to both the main channel of the Clarence River and the South Arm. Water sample results from sites in the vicinity of the Orange/A option generally complied with the ANZECC/ARMCANZ (2000) trigger values. Key water quality issues in the vicinity of the Orange/A option are:

- Bom Bom Creek exhibited low dissolved oxygen saturation at the time of sampling.
- Swan Creek exhibited low dissolved oxygen saturation and low pH, likely to be the result of algal blooms at the time of sampling.
- The South Arm of the Clarence River exhibited turbidity at slightly above the recommended limit at one site.

The general levels of compliance with the ANZECC/ARMCANZ (2000) guidelines of waterways which the Orange/A option would traverse demonstrate the need for the project to incorporate measures to mitigate against construction and operational impacts. Particular threats to water quality associated with the project include chemical or oil spills, sedimentation and nutrient loading during construction, and polluted runoff from the road surface during operation. Water quality treatment devices would be installed and maintained to minimise the impacts of these pollutants on existing aquatic systems.

Ecology

With the exception of the southern and northern sections of the Orange/A option, where some remnant and regrowth native vegetation is present, little vegetation cover exists along the Orange/A option. The Orange/A route is assessed to have the least impact to significant areas of native vegetation. **Table 7-1** summarises the main ecological impacts of the Orange/A option. It should be noted that impacts on SEPP 14 wetlands and the Yaegl Nature Reserve are based on a 100 metre nominal road reserve width. Direct impacts may be avoidable by implementation of design measures to minimise the footprint of the road in this area.

Table 7-1 Ecological Impacts of the Orange/A option

National Parks	SEPP 14 Wetlands	State Forests	EECs	High value habitat
1.4 ha	0.6 ha	14.5 ha	9.5 ha	10.4 ha

The vegetation south of Grafton generally comprises previously logged dry sclerophyll woodlands and open forests. There are also some small areas of moist to wet sclerophyll forest associated with watercourses and adjacent floodplains, representative of vegetation considered as endangered ecological communities (Swamp Sclerophyll Forest and Subtropical Coastal Floodplain Forest).

Known habitat and populations of the threatened tree species, *Eucalyptus tetraplura*, exist in the vicinity of the southern section of the Orange/A option and this species was recorded during the preliminary surveys near Bom Bom and Glenugie State Forests.

Between Grafton and Maclean, natural vegetation has all but been removed through agricultural practices and other development, particularly grazing and cane farming. Although primarily cleared, some small remnants of the Freshwater Wetland endangered ecological community remain within the Clarence River floodplain.

Between Maclean and Harwood Bridge, relatively large remnants of floodplain vegetation include the Swamp Oak Floodplain Forest and Swamp Sclerophyll Forest endangered ecological communities. Additionally, smaller patches of Subtropical Coastal Floodplain Forest are located in this area. Potential impacts on endangered ecological communities are associated with the widening of the existing highway to the north of the Yaegl Nature Reserve. At the crossing of the Clarence River there is likely to be an impact to a band of Grey Mangroves that flanks the southern riverbank. There is also potential for small patches of the Coastal Saltmarsh endangered ecological community to be present in this area.

The Orange/A option would have the least comparative potential impact on threatened fauna and significant habitats. The floodplain habitats in proximity to the existing Pacific Highway corridor are largely cleared, except for small stands of remnant trees, and have generally become degraded by long term agricultural use to the point where few habitat features of significance remain. The endangered Black-necked Stork *Ehipporhynchus asiaticus* is occasionally recorded in flooded paddocks on the western side of the highway south of Ulmarra (G. Clancy *pers.comm*) in proximity to this route. However, visitation by this species could be expected to continue, given the apparent tolerance of the modified habitat at this location adjacent to the existing road.

There are no significant impacts to wildlife corridors as a result of the Orange/A option, as it would largely follow the existing highway. A wildlife black spot is located on the existing Pacific Highway between Yaegl Nature Reserve on the east side and habitat to the north of Maclean of the west side of the highway. The need for fauna crossings at this location would be considered as part of the concept design should the Orange/A option be preferred.

Most of the waterways in the vicinity of the Orange/A option were assessed to be of a relatively poor condition for aquatic habitat due to poor riparian zones (narrow width and loss of continuity), and the impacts of adjacent agricultural land use. The option traverses the largely cleared Clarence River floodplain for much of its length. The floodplain holds a complex mosaic of wetlands and waterways. However, given the degree of existing disturbance and lack of stream connectivity, it is unlikely that fish and other aquatic fauna species of conservation significance persist in these areas. Such waterways are likely to support aquatic communities of recreational and commercial interest

(such as Australian bass, mullet and eels), and provide important food resources for fish and avian species.

Aquatic habitats would be minimally affected by the Orange/A option, provided appropriate pollution control mechanisms are maintained. Stream crossings should ensure that in-stream fish passage is not prevented.

7.2.4 Social considerations

Planning and land use

Table 7-2 summarises the key land use and planning impacts of the Orange/A option based on the assessment criteria developed for the project.

Table 7-2 Land use impacts of the Orange/A option

Criteria	Impact
Approximate number of houses within route corridor (200 metre wide corridor).	175 houses
Area of urban/ village zoned land within route corridor.	2.7 ha
Area of urban investigation zoned land within route corridor.	Nil
Area of rural residential or rural small holdings zoned land within route corridor.	1.2 ha
Area of State Forest management zone 4, 5 or 6 land within route corridor.	15.2 ha
Direct impact on national parks estate lands.	1.4 ha
Direct impacts on SEPP 14 wetlands.	0.6 ha
Direct impacts on forest management zones 1, 2 and 3A.	14.5 ha
Impacts on productive agricultural land (land classification levels 1-3).	465 ha

Note: impacts are based on a nominal 100 metre wide road reserve unless otherwise stated.

Overall, the land use impacts of the Orange/A option are assessed to be high due to the number of residences requiring acquisition. However, in comparison with other options, impacts to rural properties such as severance and changes to land use patterns would be significantly less. Land use impacts would include:

- Impacts to residences and businesses fronting the existing Pacific Highway and around Townsend.
- Edge effects on cane farms from widening of the existing highway corridor.
- Impacts on high value agricultural land within the floodplain.
- Impacts on Glenugie State Forest, although these are primarily edge effects.
- Minor encroachment into the Yaegl Nature Reserve (based on a 100 metre wide corridor). If the Orange/A option were selected as the preferred route detailed design would be undertaken to avoid direct impacts on the nature reserve, to the greatest extent possible.

Impacts have been minimised between Wells Crossing and Four Mile Lane as a result of the strategy of widening the existing road corridor to accommodate a new dual carriageway rather than

creating a new route. Impacts on rural areas would be generally high between Bom Bom and Swan Creek. Between Swan Creek and Harwood, impacts would be high as a result of the high level of impact on residences and businesses that front the highway. Impacts on cane farms would also result between approximately Cowper and Maclean.

Within the former Ulmarra Shire, the Orange/A option would mostly require widening, realignment or relocation of the existing Pacific Highway. As such, it is not covered by the exemptions to development consent established under the EP&A Model Provisions. In the event that Council considers the project to not be consistent with one or more of the objectives of zones through which it passes, it may be determined to be prohibited development (see **Section 7.1.5**). Should the project be prohibited, planning action may be required to ensure that it can be assessed as development without consent. The permissibility of the project would be further assessed once the preferred option is selected.

Indigenous and non-indigenous heritage

The Orange/A option predominantly follows the existing highway with, the exception of the section between Bom Bom and Swan Creek. In following the existing highway, it comes close to the existing towns situated along the Pacific Highway, which contain a range of European heritage or historic sites such as schools, residences, public halls and churches. Most of these sites are rated as significant in a local context and either are listed on the relevant LEP or satisfy criteria for listing.

The Orange/A option may also impact on some significant indigenous heritage sites, namely a burial, a bora/ceremonial ground and an historic campsite.

Table 7-3 summarises the potential heritage impacts of the Orange/A option. The overall potential for heritage impacts of this option is assessed to be relatively high, compared to other options under assessment.

Table 7-3 Heritage impacts summary for the Orange/A option

Option	Sites Directly Impacted			Sites Indirectly Impacted			Impact Rating
	High	Moderate	Low	High	Moderate	Low	
Orange/A	3 indigenous sites 4 historic sites	-	PADs	3 historic sites	-	-	High

Noise impacts

The number of dwellings predicted to experience noise levels within various ranges has been estimated in **Table 7-4**, based on noise modelling undertaken for the route options, and assuming noise impacts are unmitigated. These ranges relate to the base noise criteria outlined in **Section 5.4.7** for both day and night time periods for a new road as well as a redeveloped road. The upper

and lower ranges of > 65 dB(A) and > 45 dB(A) include dwellings that would experience levels greater than the base criteria and less than the base criteria respectively.

The noise modelling indicates that a substantial number of residences would potentially be affected by road noise from the Orange/A option. However, the majority of these would be expected to be residences that are already affected by noise from the existing highway. The redeveloped road criteria would be relevant criteria for much of the Orange/A option, where it is located adjacent to the existing highway. The modelling indicates that the majority of potentially noise affected residences would not experience noise levels above the relevant day or night criteria. A substantial number of residences would still be likely to be noise affected compared to other route options.

Table 7-4: Noise assessment of the Orange/A option

Noise Level Range L_{Aeq} dB(A)	No. of affected residences	
	Day	Night
>45 and ≤ 50	330	315
>50 and ≤ 55	325	275
>55 and ≤ 60	175	125
>60 and ≤ 65	90	75
≥ 65	55	25
Total	975	815

Notes:

Numbers of affected residences have been rounded up to the nearest 5, to account for the broad level assessment at this stage of the project.

- Denotes residences where the criteria for a new road are potentially exceeded
- Denotes residences where the criteria for a redeveloped road are potentially exceeded

Some residences in the higher noise level ranges are likely to be acquired because they would be located within the area of direct impact of the route option. The likely acquisition of residences has not been considered in the modelling of route options but would be expected to reduce the number of buildings affected by noise from the Orange/A option.

The Orange/A option deviates from the Pacific Highway north of Bom Bom State Forest and comes in close proximity to residences in the Clarenza area. This option would provide new exposure to a number of residences to the east of Clarenza and in the Swan Creek area.

Between the deviation south of Grafton and where the Orange/A option rejoins the highway alignment north of Swan Creek, residences fronting the highway would experience a significant reduction in road traffic noise effects. The Orange/A option would remove at least 50 per cent of heavy vehicles from these sections of the highway (based on AADT), and this would be expected to result in substantial reductions in noise levels with benefits to these residents.

Residences fronting the highway in Ulmarra, as well as the Ulmarra Public School, would experience reductions in noise levels. Residences in the east of Ulmarra would have a new noise exposure as a result of the deviation around the township.

In other sections of this option, substantial changes to noise affectation for residences on the existing highway would be unlikely. However, the distance between some residences and the road may be reduced due to location of the upgraded highway next to the existing highway, and this would increase the level of noise exposure.

Due to soils and flooding constraints, and space considerations, it was not considered possible to upgrade the existing highway alignment near Tyndale. The Orange/A option would pass to the south and east of the town. Some residences in Tyndale would experience a new noise exposure. The noise would come from a different direction (south or east rather than north or west). The overall change in noise exposure around Tyndale (in terms of the number of noise affected residences) is expected to be minimal. Some residences may experience an increase in noise, while others (near the existing highway) would experience a reduction in noise.

In the absence of noise mitigation, and leaving aside the potential acquisition of residences identified as noise affected, the Orange/A option has the greatest potential for noise impacts of all options under consideration. Noise impacted residences are spread along the existing highway alignment, but concentrations of new noise impacts would be likely to occur around Clarenza, Swan Creek, and Ulmarra. Residences in close proximity to the existing highway at Townsend would also be likely to experience increased noise affectation, as relocation of the road carriageways to create a dual carriageway road would bring traffic closer.

Visual impacts

The Orange/A option is assessed to have a relatively high potential for visual impacts. This is primarily because it is located in areas that are relatively densely settled and areas of fairly open terrain with minimal vegetation. Topographic uniformity and lack of vegetation provide few opportunities to screen the Orange/A option from view. Key visual impacts associated with the Orange/A option include:

- The southern section, from Wells Crossing to Four Mile Lane, where the Orange/A option would pass through undulating terrain requiring cuts and fills that would increase visual impacts, and a highly visible interchange with the existing highway.
- Extensive areas of floodplain that are relatively densely settled, from Bom Bom through to Ulmarra and continuing to Tyndale, where the road would be elevated to achieve flood immunity, and therefore visually prominent from a wide range of vantage points.
- Around Tyndale where a large cut would be required through an area of steeper terrain that would be highly visible from the surrounding floodplain areas and Tyndale itself.

- Potential for impacts around Maclean and Townsend, although the potential for effects is reduced as the Orange/A option generally follows the existing alignment in this area.
- Likely requirements for noise walls and other mitigation measures that may increase the visual prominence of the Orange/A option, particularly when combined with the elevated road to address flooding issues.
- Impacts on the visual character of the Clarence River and surrounding areas.
- Potential conflicts with the character and ecological values of the Yaegl Nature Reserve and SEPP14 wetland. This is a prominent landscape feature and should be integrated into the landscape design of the road.

As the Orange/A option is located generally within or adjacent to the road corridor of the existing Pacific Highway, the surrounding landscape has already been significantly influenced by major road infrastructure. However, the impacts of the existing road corridor would be substantially increased in many areas as a result of the much larger road footprint and the requirements for embankments to address flooding issues and noise mitigation measures.

7.2.5 Summary of the Orange/A option

Table 7-5 provides an overview of the impacts of the Orange/A option.

Table 7-5 Summary assessment of the Orange/A option

Criteria	Assessment of the Orange/A option
Road safety	<ul style="list-style-type: none"> ■ Orange/A option is able to be designed to achieve the target crash rate of 15 crashes per 100 million vehicle kilometres travelled, halving the crash rate for traffic using the new road. ■ Would provide safety benefits to local traffic as the majority of local traffic would use the Orange/A route in preference to the existing highway.
Traffic, transport and access	<ul style="list-style-type: none"> ■ Would attract approximately 90% of traffic from the existing highway. ■ Potential interchanges at Bom Bom and north of Swan Creek to provide access to Grafton. ■ Potential interchange south of Harwood Bridge to access Maclean and Yamba. ■ Approximately 75% of all heavy vehicles are semi-trailers or B-Doubles and the majority of these would use the Orange/A option rather than the existing highway. ■ Approximate travel time saving of eight minutes from Wells Crossing to Harwood. ■ Existing highway would be retained as an alternative route and to provide access to properties.
Engineering	<ul style="list-style-type: none"> ■ Would meet required design standards including 110km/h design speed. ■ Potential for staged construction due to proximity to existing highway. ■ Cost estimate between \$1300-1400 million (in 2005 dollars).
Topography, geology and soils	<ul style="list-style-type: none"> ■ Relatively flat terrain reduces earthworks volumes and ensures that gradients would meet design standards. ■ More than half the route length is within the floodplain, in areas of soft soils, requiring pre-loading or specific foundation designs to prevent settlement of fill. ■ High potential to encounter acid sulphate soils.

Criteria	Assessment of the Orange/A option
Drainage and flooding	<ul style="list-style-type: none"> ▪ Approximately 38 kilometres within the Clarence floodplain. ▪ Road embankments across the floodplain would be typically two to three metres high, but up to six metres high in some locations. ▪ Approximately 20-25 bridges would be required within the floodplain. ▪ Another ten bridges would be required across creeks outside the floodplain. ▪ Substantial quantities of fill material would need to be imported for embankment construction.
Water quality	<ul style="list-style-type: none"> ▪ Water quality conditions at creek crossings generally within ANZECC/ARMCANZ (2000) guideline levels. ▪ Some creeks exhibit low dissolved oxygen and pH levels, and high concentrations of turbidity.
Ecology	<ul style="list-style-type: none"> ▪ Ecological impacts are relatively minor compared to other options, as the majority of the route passes through highly disturbed floodplain areas. ▪ Approximately one kilometre of the Orange/A option passes through high value habitat (around Yaegl Nature Reserve). ▪ Minor impacts on Yaegl Nature Reserve and SEPP 14 wetland would be mitigated by specific design measures to minimise the road footprint. ▪ Impacts on Glenugie State Forest are mainly edge effects associated with widening and minor re-alignment of the existing highway.
Planning and land use	<ul style="list-style-type: none"> ▪ Approximately 175 houses, mainly fronting the existing highway, would potentially be directly affected. ▪ Land use impacts mainly relate to widening of the existing highway - edge effects rather than severance of properties. ▪ Edge effects on cane farms would result in the north of this option. ▪ Severance of rural properties between Bom Bom and Swan Creek would impact on prime agricultural land.
Heritage	<ul style="list-style-type: none"> ▪ Potential direct impacts on three Aboriginal sites of high significance. ▪ Potential impacts on four non-indigenous heritage sites of high significance. ▪ Potential indirect impacts on three non-indigenous heritage sites of high significance.
Noise	<ul style="list-style-type: none"> ▪ Approximately 225 residences potentially affected by night-time noise levels exceeding the DEC criteria for redeveloped roads, including approximately 175 houses potentially directly affected by the road corridor. ▪ Many noise affected residences may be within the road reserve and require direct acquisition.
Visual	<ul style="list-style-type: none"> ▪ Close to existing highway and major residential centres, meaning that this option is visible to a high concentration of people and would impact on the most properties. ▪ Embankment severs the relationship of properties to south-east of alignment with river. ▪ Impacts are focused on existing area of disturbance, but would be substantially increased as a result of the scale of required road infrastructure to meet design requirements.

As the Orange/A option follows the existing Pacific Highway for the most part, impacts would be associated with intensification of transport infrastructure and activity within the existing road corridor, as opposed to creation of a new corridor in areas where major transport infrastructure is otherwise absent. In terms of the overall context of the study area, upgrading of the existing corridor provides some strategic advantages. These include:

- Excellent performance in terms of achieving the safety objectives of the Pacific Highway Upgrade Program, through a significant decrease in the overall number of accidents on the road network (up to 50 per cent), as a result of approximately 90 per cent of traffic (local and

through traffic) choosing to use the new highway, which would be constructed to higher safety standards.

- A greater overall travel time saving for all vehicles using the current highway corridor, including local traffic and through traffic.¹¹
- Improvements to the efficiency of freight movement through the corridor, including a higher standard road that avoids towns and would result in travel time and cost savings for long distance freight, and provide a more direct, higher standard route for local freight to access Grafton.
- Minimal changes in noise affectation with increases in noise impacts resulting from widening of the existing road corridor expected to be small as opposed to creation of new areas of road traffic noise affectation for other route options.
- Avoidance of land use impacts such as segregation and severance of properties and changes to overall land use patterns that would arise from creation of a new road corridor.
- Avoidance of impacts on areas of significant ecological value, in particular severance of habitat corridors and areas of contiguous remnant vegetation.

It is important to understand the scale of widening and upgrading of the existing road reserve that would be required to meet the design standards for the Pacific Highway Upgrade Program. The Orange/A option would comprise a new dual carriageway motorway adjacent to the existing highway, and as a result would require major widening of the road reserve to accommodate the new road, and the existing highway as a service road. The Orange/A option performs poorly against the community objectives of the Pacific Highway Upgrade Program because of:

- Direct acquisition of a large number of residences and businesses fronting the existing highway, as well as indirect impacts to residences that would be located close to the road.
- Encroachment of the substantially widened road reserve into areas of high value for agricultural production within the Clarence Valley floodplain.
- Reinforcement of the barrier imposed by the existing highway corridor on the development of functional and physical connections between Maclean and the areas of Gulmarrad, Townsend and James Creek.

¹¹ Compared to other options, the Brown option would result in greater travel time savings for local traffic, but less travel time savings for through traffic. Because of the high proportion of local traffic that uses the Pacific Highway, the overall travel time saving for all vehicles would be greater than for other options.

7.3 Assessment of the Purple/B option

7.3.1 Overview

The Purple/B option follows the existing highway from Wells Crossing to the northern end of the Glenugie State Forest. Just north of Eight Mile Lane, it then deviates east, passing south of Grafton Airport and to the north-west of Pillar Valley. From here the option heads north again on the western side of the Pillar Range and the Pine Brush State Forest towards Tyndale. The Purple/B option skirts to the south and east of Tyndale and then to the east of the existing cane fields before rejoining the existing highway alignment just north of Shark Creek. From here the option follows the existing highway through to Harwood Bridge.

The Purple/B option is 66 kilometres long and would be constructed to Class M standards. It is likely that interchanges would be located near where this option deviates from the existing Pacific Highway near Eight Mile Lane, and in the vicinity of Harwood Bridge. The preliminary cost of the Purple/B option is between \$950 and \$1050 million in 2005 dollars.

The Purple/B option crosses approximately 13 kilometres of flood plain, and at least one carriageway would be above the 1 in 20 year flood level. Bridges would be provided at Coldstream River, Chaffin Creek, Shark Creek and other minor creeks.

7.3.2 Traffic and transport considerations

Traffic volumes, travel time and costs

The Purple/B option offers some opportunities for staged construction. The section from Wells Crossing to where this option diverts from the existing highway, and the section from Shark Creek to Harwood Bridge, could be constructed as distinct stages.

The Purple/B option would provide some benefits to through traffic in terms of travel time and distance savings. It is approximately seven kilometres shorter than the existing Pacific Highway. The travel time saving for through traffic would be approximately ten minutes, assuming a constant travel speed of 110 km/h.

The Purple/B option would provide limited benefits to local traffic, because it is located some distance from Grafton. Traffic making local trips within the study area would achieve little benefit in terms of travel time or cost savings, compared to continuing to use the existing highway. It is therefore expected that only through traffic would utilise the Purple/B option. This would mean that approximately 65-70 per cent of total traffic in the corridor, and 50 per cent of heavy vehicles, would continue to use the Pacific Highway in preference to the Purple/B option.

Safety

The Purple/B option would be designed to achieve the RTA's accident rate standard of 15 accidents per 100 MVKT. Traffic travelling on the new route would therefore benefit from improved road safety. Approximately 65-70 per cent of traffic would remain on the existing highway, and this traffic would benefit from a reduction in overall traffic volumes, and a significant reduction in heavy vehicle volumes. These factors are expected to contribute to some improvement in safety on the existing Pacific Highway, including a reduction in the number and severity of accidents.

Relationship to the local road network

Approximately 19 kilometres of the Purple/B option would be located adjacent to the existing highway, including sections from Wells Crossing to Eight Mile Lane and from Shark Creek to Ferry Park at Maclean. In these locations, two new carriageways would be constructed next to the existing highway. The existing highway would be used as a service road for local access. In both these sections, the new carriageways would be predominantly located to the east of the existing highway. Where access is required to the opposite side of the highway, a bridge would be provided either over or under the new alignment. Crossing points would be rationalised by the use of additional service roads (on the opposite side of the upgraded highway to the main service road) or upgrades to alternative routes where practical and appropriate.

From Ferry Park to the Harwood Bridge, the new highway would involve reconstruction of the existing highway. Property access from the existing highway in this section is limited. However, a service road would be provided parallel to the upgraded highway to provide an alternative route for local traffic, so as to avoid needing to travel through Maclean. Access to any affected properties would be provided via the access road.

Where the proposed alignment is away from the existing highway, the need for service roads would be minimal, as the alignment does not generally follow existing roads and therefore would have limited impacts on existing access. Where necessary, service roads would be provided in order to maintain access to properties and local roads. It is not expected that crossings (underpasses or overpasses) would be provided for all local roads crossed by the proposed alignment. Rather, the overall local road network would be reviewed and crossing points established based on road use and availability of practical alternative routes.

Where properties are split by the proposed upgrade, access would be provided across the new alignment to ensure land owners can access all parts of their property.

The actual location of interchanges would be subject to further assessment of travel demand in and around the study area. An interchange would be considered to the north of Glenugie State Forest to provide access to Grafton. Another interchange in the area around Maclean and the Harwood Bridge would be considered to provide access to Maclean and Yamba. There is limited potential

for additional interchanges between these points, because the Purple/B option would not cross roads that provide access to major population or employment centres. Consideration would be given to intermediate interchanges based on travel demand analysis, should the Purple/B option be selected as the preferred route. However, based on current and projected traffic volumes, intermediate interchanges are unlikely to be required in the short term (the next 10 to 20 years).

The potential connection between the Purple/B and Orange/A options near Tyndale (assessed in **Section 7.6**) provides opportunity for an interchange with the existing highway in the Tyndale area. However, as with other interchanges, the potential benefits of this interchange for local traffic would require further consideration before it is incorporated in the design of this option. An interchange in this location is considered unlikely to provide substantial benefits to local traffic, but may create opportunities for additional traffic making regional trips on the highway (eg to Coffs Harbour or Ballina) to access the new road.

7.3.3 Environmental considerations

Topography, geology and soils

Between Wells Crossing and Tyndale, the Purple/B option is generally located on the Southern Shale Lowlands, Eastern Hills and Valley and Central Sandstone Ridge terrain units with some short crossings of the Clarence River Floodplain soils. North of Tyndale, the option is located on Clarence River Floodplain and Eastern Hills and Valley materials, with a shorter section of Clarence River Delta Soils closer to the Harwood Bridge.

The Southern Shale Lowlands materials are well suited to the construction. Materials from cuttings would be of reasonable quality, although they are not expected to be suitable for select fill. The likelihood of finding acid sulphate soils is low through this section.

The Eastern Hills and Valley materials present reasonable construction conditions although some seams may be difficult to rip. Materials from cuttings would be of reasonable quality although are not expected to be suitable for select fill. The likelihood of acid sulphate soils through the Eastern Hills and Valley soils is low.

The Central Sandstone Ridge materials present reasonable construction conditions. Some seams may be difficult to rip and require blasting. Materials from cuttings would be of good quality with some materials from the stronger sandstones suitable for select fill. The likelihood of acid sulphate soils through the Central Sandstone Ridge soils is low.

The Clarence River Floodplain and Clarence River Delta soils are low lying and require significant amounts of fill to be imported in order to achieve the design levels required. They are likely to present difficulties with soft foundations and potentially high settlements that would require either a long period of pre-loading or alternative treatments such as installation of wick drains to

accelerate the process. The potential for acid sulphate soils through the Clarence River Floodplain and Clarence River Delta is high although this would not greatly effect construction.

Drainage and flooding

The Purple/B option has been designed to avoid significant portions of the floodplain areas south of Tyndale. North of Tyndale, this option is located within the floodplain. Overall, approximately 13 kilometres of this alignment lies within the floodplain.

As with the Orange/A option, although the existing highway is located on a levee, some sections of the alignment would need to be raised in order to achieve the required flood immunity, requiring a significant amount of fill to be brought in. Embankments would be typically 1.5 to 2.5 metres high within the floodplain, and up to five metres high in some locations between Tyndale and Shark Creek.

By locating the option further back from the river, the length of structures that would be required would be reduced, resulting in construction cost saving between Tyndale and Shark Creek, when compared to the Orange/A option. The Purple/B option requires six or eight floodplain bridges and another 20 bridges over creeks. Numerous other culverts would also be required. Overall the Purple/B option has a marginally higher cost of bridges than the Red/D and Green/C options but significantly lower than the Orange/A option.

Water quality

The Purple/B option crosses the upstream reaches of Coldstream River near Sandy Crossing and is adjacent to the downstream reaches. This option also traverses Chaffin Creek, Shark Creek and the Clarence River at Harwood.

The water quality of both Chaffin Creek and Coldstream River in the vicinity of the proposed crossings was generally good with all water quality parameters except dissolved oxygen complying with relevant guidelines. Dissolved oxygen was less than 80 per cent saturation at all four sites measured ranging between 39.5 per cent and 73.9 per cent saturation.

The water quality of Shark Creek at site 16 was good with all parameters measured within the ANZECC/ARMCANZ (2000) guidelines for estuarine ecosystems. The water quality of site 17 was slightly poorer with DO and pH below the recommended lower guideline limits.

As previously discussed the water quality of the Clarence River at Harwood meets the ANZECC/ARMCANZ (2000) trigger values for protection of aquatic ecosystems.

Ecology

The Purple/B option traverses naturally vegetated areas, both remnant and regrowth, for a large proportion of its length. The vegetation along this option is located on a variety of terrain, including floodplain areas, lower slopes and in some locations, upper slopes and ridgelines. Some areas of identified fauna habitat value are also impacted. **Table 7-6** summarises the ecological impacts of the Purple/B option. Relative to other options the ecological impacts of this option are assessed to be moderate. Impacts on the Yaegl Nature Reserve and SEPP 14 wetland are based on a nominal 100 metre wide corridor, and may be minimised or avoided by minimising the footprint of the road and adjusting the alignment.

Table 7-6 Ecological impacts of the Purple/B option

National Parks	SEPP 14 Wetlands	State Forests	EECs	High value habitat
1.4 ha	0.6 ha	12 ha	49.7 ha	102 ha

The vegetation in the southern section of this option is generally comprised of previously logged dry sclerophyll woodlands and open forests. There are also some small areas of moist to wet sclerophyll forest associated with watercourses and adjacent floodplains, which are representative of vegetation the Swamp Sclerophyll Forest and Subtropical Coastal Floodplain Forest endangered ecological communities. The southern section of the Purple/B option is located in an area that contains known habitat and populations of the threatened tree species, *Eucalyptus tetraplura*. This species was recorded during the preliminary surveys in vegetation near Bom Bom and Glenugie State Forests.

The central section of this option passes through some relatively large areas of lowland floodplain vegetation. While much of the floodplain has been cleared, areas through which the Purple/B option passes around Wants Lane, contain vegetation that is considered as being representative of the Swamp Sclerophyll Forest, Freshwater Wetlands and (to a lesser extent Subtropical Coastal Floodplain Forest) endangered ecological communities. Potential for impacts is greatest in the floodplain and swampy areas associated with Coldstream River and Pillar Valley Creek. Impacts would also occur to stands of drier sclerophyll forest in the elevated vegetation to the east of Tucabia, and potentially small patches of the Subtropical Coastal Floodplain Forest endangered ecological community. Some of these areas are in reasonable condition as they have been selectively logged only. However, many sections have been heavily logged and grazed over a long period, and as a result have poorly represented understorey vegetation. Recent wild fires have also impacted this area.

The northern section of the option contains large sections of remnant vegetation to the east and south of Maclean and within the Shark Creek and Tyndale Swamp areas. These include relatively large remnants of the Freshwater Wetlands, Swamp Oak Floodplain Forest and Swamp Sclerophyll

Forest endangered ecological communities, and smaller patches of Subtropical Coastal Floodplain Forest. At the crossing of the Clarence River there is likely to be an impact to a band of Grey Mangroves that flank the riverbanks. There may also be potential for minor patches of the Coastal Saltmarsh endangered ecological community to be present in this area.

The Purple/B option traverses forests along the western side of the Shark Creek Range that exhibit high quality fauna habitats. These are particularly evident from Chaffin Creek to Bostocks Road and the western parts of Pine Brush State Forest. The impacts from logging in this location are more restricted and limited in extent compared to the floodplain to the west around Tucabia and on the eastern side of the range within Newfoundland State Forest. These forests exhibit a higher density of mature trees, well-developed habitat structure and high floristic diversity. As a result several threatened fauna species could be expected to occur, such as the Rufous Bettong, Squirrel Glider, Powerful Owl, Brush-tailed Phascogale, and microchiropteran bats.

The Purple/B option traverses in proximity to the lower end of Crowsnest Swamp. This area has been identified as a significant nesting area for the endangered Black-necked Stork (*G. Clancy pers.comm*) and provides regionally significant habitat for a diversity of fauna species.

The waterways in the vicinity of the Purple/B option illustrate a mixed environmental condition, though none could be considered in pristine condition. Riparian zones vary from good to poor (narrow width and loss of continuity). The predominantly agricultural land use is a major contributor to the condition of those waterways that are assessed as being in relatively poor condition. The Purple/B option poses the greatest threat to the ecological values of waterways in the southern section, where it traverses the middle reaches of most streams. The presence of large, permanent pools within Coldstream River and Chaffin Creek provide a complexity of habitats. Previous survey data are insufficient to discount the presence of the significant species Eastern Cod, which favours such large pools, however, there is a low likelihood that the species persists in the study area.

7.3.4 Social considerations

Planning and land use

Table 7-7 summarises the key land use and planning impacts of the Purple/B option, based on the assessment criteria developed for the project.

Table 7-7 Land use impacts of the Purple/B option

Criteria	Impact
Approximate number of houses within route corridor (200 metre wide corridor).	35 houses
Area of urban/ village zoned land within route corridor.	0.7 ha
Area of urban investigation zoned land within route corridor.	Nil
Area of rural residential or rural small holdings zoned land within route corridor.	Nil
Area of State Forest management zone 4, 5 or 6 land within route corridor.	32 ha
Direct impact on national parks estate lands.	1.4 ha
Direct impacts on SEPP 14 wetlands.	0.6 ha
Direct impacts on forest management zones 1, 2 and 3A.	12 ha
Impacts on productive agricultural land (land classification levels 1-3).	263 ha

Note: impacts are based on a nominal 100 metre wide road reserve unless otherwise stated.

Overall, the land use and planning impacts of the Purple/B option are moderate, compared to other options. Direct impacts to residences, urban areas and villages would be minimal, except in the area between Shark Creek and Townsend, and to a lesser extent west of Pillar Valley around Wooli Road and Wants Lane. The main impacts of the Purple/B option include:

- Severance of rural land (grazing and cane farms).
- Impacts to houses in Townsend, where widening of the existing road corridor is required.
- Minor encroachment into the Yaegl Nature Reserve (based on a 100 metre wide corridor). However, the road would be designed to avoid direct impacts on the nature reserve to the greatest extent possible.

Within the former Ulmarra Shire, the Purple/B option would require either widening, realignment or relocation of the existing Pacific Highway, or formation of a means of access to a road. As such, it is not covered by the exemptions to development consent established under the EP&A Model Provisions. In the event that council considers the project is not consistent with one or more of the objectives of zones through which it passes, it would be prohibited development (see **Section 7.1.5**). Should the project be prohibited, planning action may be required to ensure that it can be assessed as development without consent. The permissibility of the project would be further assessed once the preferred option is selected.

Indigenous and non-indigenous heritage

The alignment for the Purple/B option crosses a range of environmental and topographic zones with potential to contain indigenous heritage sites. It may impact on three artefact scatters but also crosses the sandstone range south of Tyndale, where a shelter with potential archaeological deposit was located. The sandstone ridge has good potential for other shelters to occur and such areas could also contain rock art, although none has been recorded to date. This area is considered to require further detailed investigation should the Purple/B option be preferred. **Table 7-8** provides a summary of the potential heritage impacts of the Purple/B option. Overall, the potential for heritage impacts from the Purple/B option is considered to be low.

Table 7-8 Heritage impacts summary for the Purple/B option

Option	Sites Directly Impacted			Sites Indirectly Impacted			Impact Rating
	High	Moderate	Low	High	Moderate	Low	
Purple/B	-	-	2 indigenous sites	2 historic sites	1 indigenous site	1 indigenous site	Low

Noise impacts

The number of dwellings predicted to experience noise levels within various ranges has been estimated in **Table 7-9**, based on noise modelling undertaken for the route options, and assuming noise impacts are unmitigated. These ranges relate to the base noise criteria outlined in **Section 5.4.7** for both day and night time periods for a new road as well as a redeveloped road. The upper and lower ranges of > 65 dB(A) and > 45 dB(A) include dwellings that would experience noise levels greater than the base criteria and less than the base criteria respectively.

Table 7-9 Noise assessment of the Purple/B option

Noise Level Range L_{Aeq} dB(A)	No. of affected residences	
	Day	Night
>45 and ≤ 50	85	120
>50 and ≤ 55	60	60
>55 and ≤ 60	10	15
>60 and ≤ 65	10	10
≥ 65	5	5
Total	170	210

Notes:

Numbers of affected residences have been rounded up to the nearest 5, to account for the broad level assessment at this stage of the project.



Denotes residences where the criteria for a new road are potentially exceeded



Denotes residences where the criteria for a redeveloped road are potentially exceeded

The modelling for the Purple/B option indicates that a relatively high number of residences would be potentially subjected to additional noise impacts as a result of this option. As the Purple/B option would be likely to involve a mix of new road and redevelopment of the existing highway, it is likely that different criteria would apply to various sections of the road. The vast majority of potentially affected residences would be below the daytime noise criteria established for the project, for both new and redeveloped roads. The night time noise criteria for a new road would be exceeded at under half the total number of properties potentially affected. Only a small proportion of potentially affected residences would be unlikely to meet the criteria for a redeveloped road. More than half the potentially affected residences would be below the night time criteria for both new and redeveloped roads.

Key areas of noise exposure for the Purple/B option include:

- Several residences to the east of the Grafton Airport.
- Residences around Old Six Mile Lane, Wooli Road and Wants Lane.
- Residences along Coldstream Road between Tucabia and Tyndale.
- Residences in Townsend may experience increased noise exposure as a result of duplication of the existing highway.

Residences fronting the existing highway between where the Purple/B option deviates near the airport, and South Grafton, and north of Grafton through to Shark Creek, would be expected to experience a reduction in road traffic noise as a result of the Purple/B option. In particular, removal of approximately 50 per cent (AADT) of heavy vehicles from the existing highway would reduce noise at all times of the day (but particularly at night) for these residences.

Visual impacts

The visual impacts of the Purple/B option are generally assessed to be moderate. In some locations the Purple/B option follows the existing Pacific Highway and impacts would be associated with substantial expansion of the scale and visual dominance of road infrastructure. These areas are also the more highly populated parts of the study area, and the visual impacts of the project would be noticed by more people. In other areas, the Purple/B option would create new visual impacts as a result of a new major road corridor through areas that have a predominantly rural or bushland character. The main visual impacts of the Purple/B option are:

- The southern section, from Wells Crossing to north-west of Eight Mile Lane, where the Purple/B option would pass through undulating terrain requiring cuts and fills that would increase visual impacts. An interchange with the existing highway between Wells Crossing and Grafton would be visually prominent.

- Impacts of a new route between Glenugie and Tyndale, although these impacts would in part be mitigated by location of this option at the boundary of different land use units (eg. farmland and bush).
- Impacts of a new road alignment through relatively open floodplain areas south of Tucabia, where the proposal would be relatively visually prominent as a result of broad vistas and the need to elevate the road to achieve flooding immunity.
- Areas through the coastal ranges where relatively large cuts and fills would be required, resulting in a large road footprint and potential for increased visibility from the surrounding area.
- Around Tyndale where a large cut would be required through an area of steeper terrain that would be highly visible from the surrounding floodplain areas and Tyndale itself.
- Potential for impacts around Maclean and Townsend, although these the potential for effects is reduced as the Purple/B option generally follows the existing alignment in this area.
- Likely requirements for noise walls and other mitigation measures that may increase the visual prominence of the Purple/B option, particularly when combined with the elevated road to address flooding issues.
- Impacts on the visual character of the Clarence River and surrounding areas.
- Potential conflicts with the character and ecological values of the Yaegl Nature Reserve and SEPP14 wetland. This is a prominent landscape feature and should be integrated into the landscape design of the road.

The Purple/B option is located on the western foothills of the Pillar and Shark Ranges. The foothills of the Pillar Range provide topography which can accommodate the road formation and have varied cover allowing views to be restricted or revealed. The potential for impacts is generally mitigated by the topography and vegetation cover in this setting. At the southern end of this section the alignment has a relatively high visual sensitivity due to its proximity to Tucabia. The potential to mitigate this through earth works and vegetation cover should be possible within this context.

7.3.5 Summary of the Purple/B option

Table 7-10 provides a summary of the impacts of the Purple/B option.

Table 7-10 Summary assessment of the Purple/B option

Criteria	Assessment of the Purple/B option
Road safety	<ul style="list-style-type: none"> ▪ Purple/B option is able to be designed to achieve the target crash rate of 15 crashes per 100 million vehicle kilometres travelled, halving the crash rate for traffic using the new road. ▪ Some improvement in traffic safety for traffic using the existing highway from reductions in traffic volumes and heavy vehicle volumes on the existing highway.
Traffic, transport and access	<ul style="list-style-type: none"> ▪ Would attract only small volumes of local traffic from the existing highway. ▪ Approximately 30-35% of vehicles are through traffic and would use the Purple/B route. ▪ Approximately 50% of heavy vehicles are through traffic and would use the Purple/B route. ▪ Approximately 75% of heavy vehicles are semi-trailers or B-Doubles and approximately 60% of these are through traffic that would use the Purple/B option rather than the existing highway. ▪ Travel time saving for through traffic from Wells Crossing to Harwood would be approximately 10 minutes. ▪ Potential interchange locations include Glenugie and south of Harwood Bridge.
Engineering	<ul style="list-style-type: none"> ▪ Would be designed to achieve the road design standards for the Pacific Highway Upgrade project, including 110km/h design speed. ▪ Some opportunities for staged construction, from Wells Crossing to Glenugie and from Shark Creek to Harwood Bridge. ▪ Cost estimate of between \$950-1050 million (in 2005 dollars).
Topography, geology and soils	<ul style="list-style-type: none"> ▪ Generally undulating terrain outside the floodplain for the majority of this route would provide good conditions for road construction. ▪ Sections of this route within the floodplain and affected by soft soils, requiring pre-loading or specific foundation designs to prevent settlement of fill. ▪ Areas of large earthworks volumes would be limited to Bondi Hill, around Tyndale.
Drainage and flooding	<ul style="list-style-type: none"> ▪ Approximately 13 kilometres of this route would be within the floodplain. ▪ Significant fill volumes would be required to provide the required flood immunity in some sections between Tyndale and Shark Creek. ▪ Embankments would be typically 1.5 to 2.5 metres high within the floodplain, and up to five metres high between Tyndale and Shark Creek. ▪ Approximately six to eight bridges would be required within the floodplain. ▪ Approximately 20 bridges would be required to cross creeks outside the floodplain.
Water quality	<ul style="list-style-type: none"> ▪ Water quality of creeks where crossings would be required is generally good, with the exception of low dissolved oxygen at some sites.
Ecology	<ul style="list-style-type: none"> ▪ Ecological impacts would be moderate. ▪ Minor impacts on Yaegl Nature Reserve and SEPP 14 wetland are able to be mitigated by specific design measures to minimise the road footprint. ▪ Impacts on Glenugie State Forest include edge effects and severance of the north-western area of the forest. ▪ Impacts on endangered ecological communities would occur in the floodplain areas around Coldstream River and Pillar Valley Creek. ▪ Some severance of areas of high habitat value to the east of Tucabia and around Bondi Hill and Shark Creek (approximately ten kilometres in total). ▪ Impacts on important habitat corridors would be limited.

Criteria	Assessment of the Purple/B option
Planning and land use	<ul style="list-style-type: none"> ▪ Approximately 90 houses would be potentially directly affected. ▪ Potential impacts on urban areas would be limited to indirect impacts through Townsend associated with duplication of the existing alignment. ▪ Approximately 265 ha of prime agricultural land would be affected, including grazing land around the Coldstream River and sugar cane farms around Shark Creek.
Heritage	<ul style="list-style-type: none"> ▪ Overall heritage impacts would be low, relative to other options. ▪ Two Aboriginal sites of low significance would be potentially directly impacted. ▪ Two historic sites of high significance would be potentially indirectly affected. ▪ One Aboriginal site of moderate significance and one site of low significance would be potentially indirectly affected.
Noise	<ul style="list-style-type: none"> ▪ Approximately 65 dwellings would be affected by night time noise levels exceeding DEC criteria for new roads, including approximately 35 houses potentially directly affected by the road corridor.
Visual	<ul style="list-style-type: none"> ▪ Provides a diverse and varied visual experience for road users. ▪ Utilises existing highway alignment at its southern and northern limits, however, visual impacts on the local area would be greater than currently resulting from the existing road due to the scale of the infrastructure required to meet design standards. ▪ Generally follows the edges of land use units, thereby integrating with its surroundings.

The Purple/B option in part follows the existing highway and in part would be a new route corridor. The combination of route selection strategies for this option provides some strategic advantages in the context of the study area. The Purple/B option performs well against the Pacific Highway Upgrade Program objectives in relation to:

- Avoiding the impacts of a new route corridor through areas of future urban or rural residential growth, including Clarenza and Gulmarrad/James Creek.
- Utilising sections of the existing highway that have relatively good alignments and flood immunity, thus offering value for money.
- Avoiding core areas of high habitat value in the east of the study area.
- Effective bypasses of towns along the existing highway including Swan Creek, Ulmarra and Tyndale, improving travel time and minimising the risk of accidents.
- A reduction in night time noise on the existing highway (in sections where the Purple/B option is a new route), as a result of heavy vehicles using the Purple/B option.
- Potential to tie in with the existing highway at several locations, should travel demand require it, to maximise accessibility opportunities to local centres.

The Purple/B option would have the potential to result in new and adverse impacts associated with the creation of a major new road corridor in areas that are currently not subject to road traffic impacts. The split of traffic between the existing highway and the Purple/B option would result in two major transport corridors through the study area. The new corridor would create new effects in addition to the existing highway, which would continue to have substantial impacts due to the relatively high volume of remaining traffic. Particular community and environmental impacts of

the Purple/B option, when assessed against the objectives of the Pacific Highway Upgrade Program, include:

- Noise and visual impacts would be introduced to parts of the study area that are relatively undeveloped and remote.
- Some severance of rural properties would occur although these impacts would be mitigated through design measures as far as practicable.
- Impacts on endangered ecological communities would be high relative to other options.

7.4 Assessment of the Green/C option

The Green/C option deviates from the existing highway at Bald Knob Road, north of Wells Crossing and generally follows the eastern side of the study area right through to the Clarence River at Harwood. North of Pillar Valley, the Green/C option passes through the Pine Brush State Forest and would likely require a bridge crossing of the eastern extent of the SEPP 14 wetland north of the forest. In the north, the Green/C option is located east of Gulmarrad, Townsend and James Creek and rejoins the existing highway alignment at the southern end of the existing Harwood Bridge.

The Green/C option is approximately 60 kilometres long of which five kilometres crosses the Clarence River floodplain, in the north around James Creek and Gulmarrad, and at Shark Creek. Within the floodplain, at least one carriageway would be provided above the 1 in 20 year flood level. Bridges would be provided at Coldstream River, Chaffin Creek, Shark Creek and other minor creeks. The preliminary cost of the Green/C option is between \$700 and \$800 million in 2005 dollars.

7.4.1 Traffic and transport considerations

Traffic volumes, travel time and costs

The Green/C option offers no opportunities for staged construction as it does not intersect with the existing highway at any intermediate locations.

The Green/C option would provide significant benefits to through traffic in terms of travel time and distance savings. It is approximately 12.5 kilometres shorter than the existing Pacific Highway. The travel time saving for through traffic would be approximately 13 minutes, assuming a constant travel speed of 110 km/h.

The Green/C option would provide limited benefits to local traffic, because it is located some distance from Grafton. Traffic making local trips within the study area would achieve little benefit in terms of travel time or cost savings, compared to continuing to use the existing highway. It is therefore expected that only through traffic would utilise the Green/C option. This would mean

that approximately 65-70 per cent of total traffic in the corridor, and 50 per cent of heavy vehicles, would continue to use the Pacific Highway in preference to the Green/C option.

Safety

The Green/C option would be designed to achieve the RTA's accident rate standard of 15 accidents per 100 MVKT. Traffic travelling on the new route would benefit from improved road safety. Approximately 65-70 per cent of traffic would remain on the existing highway and this traffic would benefit from a reduction in overall traffic volumes, and a significant reduction in heavy vehicle volumes. These factors are anticipated to contribute to some improvement in safety on the existing Pacific Highway, including a minor reduction in the number and severity of accidents.

Relationship to the local road network

The Green/C option does not generally follow existing roads and therefore has less potential to affect existing access to property. The need for service roads would therefore be expected to be minimal. Where necessary, service roads or alternative access routes would be provided in order to maintain access to properties and local roads. It is not expected that crossings (underpasses or overpasses) would be provided for all local roads crossed by the proposed alignment. Rather, the overall local road network would be reviewed and crossing points established based on road use and availability of practical alternative routes.

Where properties are split by the proposed upgrade, access would be provided across the new alignment to ensure land owners can access all parts of their property.

The actual location of interchanges would be subject to further assessment of travel demand in and around the study area. Interchanges may be located at Wells Crossing to provide access to and from Grafton, and south of the Harwood Bridge to provide access to Maclean and Yamba. There is limited potential for additional interchanges between these points because the Green/C option would not cross roads that provide access to major population or employment centres. Current understanding of local traffic movements to coastal areas such as Brooms Head and Wooli/Minnie Water indicates that interchanges at Brooms Head Road and Wooli Road may not be justifiable. Interchanges at these locations would provide little benefit to other local traffic, such as access to Grafton or Maclean.

7.4.2 Environmental considerations

Topography, geology and soils

The Green/C option presents less geotechnical risk than the other routes as it minimises crossings of Clarence River Floodplain and Clarence River Delta terrain units. The only locations where these materials are encountered are across the SEPP 14 wetland north of Pine Brush State Forest, and a short section east and north of Gulmarrad and James Creek. Other sections of the option are located on Southern Shale Lowlands, Eastern Hills and Valley and Central Sandstone Ridge materials. As discussed in **Section 5.3.1**, these materials present little constraint to construction.

The likelihood of acid sulphate soils for this option is low, with the exception of short sections of the option within the Clarence River Floodplain and Clarence River Delta terrain units. Acid sulphate soils would not greatly effect construction as the road would be predominantly located on fill through these areas.

The main geotechnical constraints to the Green/C option are around Shark Creek and east and north of Gulmarrad and James Creek. The Clarence River Floodplain and Clarence River Delta soils are low lying and would require significant amounts of fill to be imported in order to achieve the required design levels for flood immunity. These terrain units are likely to present difficulties with soft foundations and potentially high settlement rates that would require either a long period of pre-loading or alternative treatments such as installation of wick drains to accelerate the process. However, this option passes through these soil types for a relatively short distance compared with other options and soil conditions are not considered to be a substantial constraint.

Drainage and flooding

The alignment of the Green/C option avoids the majority of the Clarence River floodplain with the exception of approximately five kilometres at the northern end. Where the alignment is within the floodplain, fill materials would be required in order to produce flood immunity for one carriageway to the 1 in 20 year event. Embankments would be typically two to three metres high, and up to six metres high in some locations in the floodplain.

Compared to other options, the Green/C option is the least affected by flooding, with only two floodplain crossings required. An additional 20 creek crossings would be required outside the floodplain, along with numerous other culverts.

Water quality

The Green/C option would require crossings of the upstream reaches of Coldstream River and Chaffin Creek, Pillar Valley Creek and Amos Creek. South-east of Harwood the Green/C option crosses an unnamed tributary near the Clarence River at Harwood and the Clarence River itself.

The option is in the vicinity of both Shark Creek and an unnamed tributary at Brooms Head Road in the Yuraygir National Park. At the time of the sample, Shark Creek failed to comply with the relevant ANZECC/ARMCANZ (2000) guidelines for protection of aquatic ecosystems for both dissolved oxygen and pH. This site was densely inhabited with aquatic plants, which is likely to have contributed to the low dissolved oxygen levels recorded. At the time of sampling, the unnamed tributary was not flowing and only a stagnant shallow pool, heavily covered in algae, was evident. No measurements could be taken due to the shallowness of the pool.

Ecology

The Green/C option traverses forests located on the Pillar Range and Shark Creek Range along the south-eastern side of the investigation area. The eastern part of the study area is a mix of private land and state forests. Forested areas on private land generally present higher quality ecological conditions, because logging has been less intensive than in state forests. As a consequence, these habitats comprise a greater density of mature trees and higher structural and floristic diversity and provide regionally significant flora and fauna habitat, particularly important for local populations of threatened fauna. Several threatened fauna species are known, or could potentially occur, in these areas. **Table 7-11** summarises the key ecological impacts of the Green/C option, based on the nominal road reserve width of 100 metres. Overall, the Green/C option would have a relatively high ecological impact, due to impacts on remnant vegetation, high quality flora and fauna habitat and aquatic habitats that, in the context of the study area, have a relatively high value.

Table 7-11 Ecological impacts of the Green/C option

National Parks	SEPP 14 Wetlands	State Forests	EECs	High value habitat
Nil	3.6 ha	9 ha	31.3 ha	255 ha

The vegetation in the southern section of the Green/C option comprises both previously heavily logged and high quality selectively logged dry sclerophyll woodlands and open forests. Some small areas of moist to wet sclerophyll forest, associated with watercourses and adjacent floodplains, are representative of the Swamp Sclerophyll Forest and Subtropical Coastal Floodplain Forest endangered ecological communities. The area through which the southern section of the Green/C option passes contains known habitat and populations of the threatened tree species, *Eucalyptus tetraplura*, identified from records and during the field surveys near Bom Bom and Glenugie State Forests. This option traverses an area of Glenugie State Forest and adjacent similarly vegetated areas likely to contain this species.

The Green/C option would impact on stands of drier sclerophyll forest in the elevated vegetation to the east of Tucabia (in the Pillar Range), Pine Brush State Forest and the foothills adjacent to the Shark Creek Range and the Coastal Range. Small patches of the Subtropical Coastal Floodplain Forest endangered ecological community are likely to occur in this area. Some of these areas are in reasonable condition as they have been selectively logged only. However, many sections have been heavily logged and grazed over a long period and the floristic diversity and condition of understorey vegetation has been highly impacted, with the exception of grasses. Recent wild fires have also impacted some forested areas. There is also potential for small pockets of the Lowland Rainforest endangered ecological community to be present in the gullies associated with the elevated portions along the option. Patches of low lying floodplain areas to the west of the Shark Creek Range, within the Tyndale Swamp area, are likely to contain portions of the Swamp Sclerophyll Forest and Freshwater Wetlands endangered ecological communities.

The northern portion of the Green/C option passes through large areas of floodplain vegetation including the Freshwater Wetland, Swamp Oak Forest and Swamp Sclerophyll endangered ecological communities, with potential impacts on small areas of Subtropical Coastal Floodplain Forest. At the crossing of the Clarence River there is likely an impact to a band of Grey Mangroves flanking the riverbanks. There may also be potential for minor patches of the Coastal Saltmarsh endangered ecological community to be present in this area. The Green/C option would impact on substantial areas of native vegetation.

These vegetation remnants impacted by the Green/C option are contiguous with and similar in quality to those in Yuraygir National Park and as such provide significant opportunities for wildlife movement. Habitat linking the Coastal Range to Shark Creek Range and to floodplain habitats further west would be intersected by the Green/C option. This area provides a significant wildlife corridor linking Yaegl Nature Reserve and the habitats around Gulmarrad across to Yuraygir National Park to the east of the investigation area. The habitat of the endangered coastal Emu population, which is known from the Gulmarrad area, would be impacted by the Green/C option.

The majority of waterway crossings would be within the upper reaches of tributaries of the Clarence River. In the context of aquatic habitats in the study area, upper catchment waterways were assessed to have better stream condition than those streams lower in the catchment due to the retention of riparian zones and other attributes such as in-stream habitat. Whilst it is unlikely that fish species of conservation significance exist in these waterways, the prevalence of small wetlands and ephemeral creeks, together with relatively low impact land use, increase the likelihood that the endangered dragonfly *Petalura gigantea* may exist along this option. Impacts arising from the Green/C option have the potential to extend for some distance downstream, and without appropriate mitigation may include reduction in the habitat values of numerous large permanent waterbodies and wetlands of conservation significance.

7.4.3 Social considerations

Planning and land use

Table 7-12 summarises the key land use and planning impacts of the Green/C option.

Table 7-12 Land use impacts of the Green/C option

Criteria	Impact
Approximate number of houses within route corridor (200 metre wide corridor).	5 houses
Area of urban/ village zoned land within route corridor.	Nil
Area of urban investigation zoned land within route corridor.	Nil
Area of rural residential or rural small holdings zoned land within route corridor.	0.4 ha
Area of State Forest management zone 4, 5 or 6 land within route corridor.	90 ha
Direct impact on national parks estate lands.	Nil
Direct impacts on SEPP 14 wetlands.	3.6 ha
Direct impacts on forest management zones 1, 2 and 3A.	4.8 ha
Impacts on productive agricultural land (land classification levels 1-3).	115 ha

Note: impacts are based on a 100 metre wide corridor unless otherwise stated.

Overall, the land use impacts of the Green/C option are considered to be moderate to high. Main land use impacts of the Green/C option would include:

- Impacts on the Pine Brush State Forest (including conservation and timber production uses).
- Direct impacts on the Shark Creek SEPP 14 wetland, including severance of the wetland, albeit at a narrow point.
- Potential indirect and direct impacts on residences in the Pillar Valley, Bostock Road, Brooms Head Road and James Creek Road areas.
- Impacts on cane farms north of Brooms Head Road to Harwood Bridge.

As with other options, further consultation with Clarence Valley Council is required to confirm the permissibility of this option within the former Ulmarra Shire area under Ulmarra LEP 1992 and planning action may be required to ensure that it can be assessed without development consent. The Green/C option would impact on land zoned both 2 and 3A in Pine Brush State Forest and to a lesser extent in Glenugie State Forest totalling approximately nine hectares. Development consent would be required (and the project would be designated development) as a result of impacts on the SEPP 14 wetland.

Indigenous and non-indigenous heritage

The Green/C option has the potential to directly impact on three sites containing Aboriginal artefact scatters, although these sites were rated as having low archaeological significance on current information. The Green/C option also passes close to four Aboriginal sites located in topographic features (spur crests) that have potential for additional sites.

This route option avoids the major towns and therefore has limited potential to directly impact on significant non-indigenous sites. The James Creek floodgates would be impacted. This site has recently been identified by the Clarence Valley Council as having high local significance and worth listing on the LEP. The two wells in close proximity to the James Creek floodgates would also be impacted by this option.

The general potential for other sites to occur within the alignment is rated as high, particularly for Aboriginal sites. The alignment passes through topographies and environments that are well suited to Aboriginal occupation, particularly the flat spur crests elevated above the swamps and floodplain. **Table 7-13** provides a summary of the potential heritage impacts of the Green/C option. Overall, the potential for heritage impacts from this option is assessed to be high, relative to other options.

Table 7-13 Heritage impacts summary for the Green/C option

Option	Sites Directly Impacted			Sites Indirectly Impacted			Impact Rating
	High	Moderate	Low	High	Moderate	Low	
Green/C	1 historic site	1 historic site	5 indigenous sites	2 historic sites	1 indigenous site	-	Moderate to high

Noise impacts

The number of dwellings predicted to experience noise levels within various ranges has been estimated in **Table 7-14**, based on noise modelling undertaken for the route options, and assuming noise impacts are unmitigated. These ranges relate to the base noise criteria outlined in **Section 5.4.7** for both day and night time periods for a new road as well as a redeveloped road. The upper and lower ranges of > 65 dB(A) and > 45 dB(A) include dwellings that would experience levels greater than the base criteria and less than the base criteria respectively.

Table 7-14: Noise assessment of the Green/C option

Noise Level Range L_{Aeq} dB(A)	No. of affected residences	
	Day	Night
>45 and ≤ 50	90	95
>50 and ≤ 55	20	25
>55 and ≤ 60	5	5
>60 and ≤ 65	5	5
>65	0	0
Total	120	130

Notes:

Numbers of affected residences have been rounded up to the nearest 5, to account for the broad level assessment at this stage of the project.



Denotes residences where the criteria for a new road are potentially exceeded

Denotes residences where the criteria for a redeveloped road are potentially exceeded

The noise criteria for new roads are relevant for this option. The modelling results for the Green/C option indicate a relatively low number of potentially noise affected residences, compared to the Purple/B and Orange/A options. Only a very small proportion of the potentially noise affected residences would be likely to experience noise levels exceeding the daytime or night time noise criteria for a new road. The key findings of the noise assessment are:

- Noise impacts would be minimal south of the Pillar Valley community due to the sparse population.
- The Green/C option would pass within 200 metres of several residences in the Pillar Valley area, around Wooli Road.
- The option would pass close to residences in the Bostock Road area, east of Tucabia.
- A good noise buffer would be provided to the residences south of Taloumbi and in the Gulmarrad area, but the option would be within 300m of residences to the north of Brooms Head Road.
- New noise exposure would result from the Green/C option to residences mainly to the east of James Creek Road.

Visual impacts

Overall, the visual impacts of the Green/C option are assessed to be relatively high. The Green/C option would be an entirely new road corridor, and for much of its length would pass through areas that have not historically been subject to a high degree of modification as a result of human activity. Existing bushland and topography create some opportunities to shield this option from view from surrounding areas. The main visual impacts of the Green/C option are:

- Large cuts and fills through areas of high relief terrain resulting in a large road footprint in some locations and significant clearing of remnant vegetation.
- Potential impacts around Pillar Valley, at the crossing of Wooli Road, where the Green/C option has the potential to become a significant feature in an otherwise rural and bushland environment.
- To the east of Gulmarrad and James Creek, where the Green/C option passes relatively close to rural residential areas and is likely to be visible to a relatively large number of residents.

Vegetation along the Green/C option is typically forested lands which provide a sense of enclosure and would screen the option from view from surrounding properties and local roads. Consequently, there are limited opportunities to view the proposal and the alignment has a low visual sensitivity in these environments. The Green/C option also has the advantage of being located in relatively undeveloped areas, where population density is low, and consequently fewer people would be exposed to the road.

7.4.4 Summary of the Green/C option

Table 7-15 summarises the impacts of the Green/C option.

Table 7-15 Summary assessment of the Green/C option

Criteria	Assessment of the Green/C option
Road safety	<ul style="list-style-type: none"> ▪ Can be designed to achieve the target crash rate of 15 crashes per 100 million vehicle kilometres travelled, halving the crash rate for traffic using the new road. ▪ Some improvement in traffic safety for traffic using the existing highway from reductions in traffic volumes and heavy vehicle volumes on the existing highway.
Traffic and transport	<ul style="list-style-type: none"> ▪ The Green/C option is the shortest of the route options. ▪ Would attract very little local traffic from the existing highway. ▪ Approximately 30-35% of vehicles would be through traffic and would use the Green/C option. ▪ Approximately 50% of heavy vehicles are through traffic would use the Green/C option. ▪ Approximately 75% of heavy vehicles are semi-trailers or B-Doubles and approximately 60% of these are through traffic that would use the Green/C option rather than the existing highway. ▪ The travel time saving for through traffic between Wells Crossing and Harwood Bridge would be approximately 13 minutes. ▪ Potential interchange locations include Bald Knob Road and south of Harwood Bridge.
Engineering	<ul style="list-style-type: none"> ▪ Would be designed to achieve the standards required for the Pacific Highway Upgrade Program, including 110km/h design speed. ▪ No opportunities for staged construction. ▪ Cost estimate of between \$700-800 million (in 2005 dollars).
Topography, geology and soils	<ul style="list-style-type: none"> ▪ Generally topography and soils present minimal constraint to the Green/C option. ▪ Floodplain soils would be traversed for relatively short distances around Shark Creek and north of Brooms Head Road - some potential to encounter soft soils and acid sulphate soils. ▪ Earthworks volumes would be significant, but cut and fill volumes would be balanced.
Drainage and flooding	<ul style="list-style-type: none"> ▪ Approximately five kilometres of this option would be within the floodplain, around Shark Creek and north of Brooms Head Road. ▪ Embankments would be typically two to three metres high, and up to six metres high in some locations in the floodplain. ▪ Two bridges would be required within the floodplain, and a further 20 bridges across creeks outside the floodplain.
Water quality	<ul style="list-style-type: none"> ▪ Water quality of creeks along this route option is relatively good, with the exception of low dissolved oxygen and pH levels in Shark Creek.
Ecology	<ul style="list-style-type: none"> ▪ Ecological impacts of this option would be high. ▪ High potential for impacts on high value fauna habitat and fauna corridors for approximately 25 kilometres of this option, in particular around Pillar Valley, Shark Creek, and Brooms Head Road. ▪ Direct impacts on the Shark Creek SEPP 14 wetland. ▪ Impacts on remnant endangered floodplain vegetation communities in the Shark Creek and Gulmarrad areas. ▪ Impacts on identified habitat links between high ecological value areas within the Pine Brush State Forest.

Criteria	Assessment of the Green/C option
Planning and land use	<ul style="list-style-type: none"> ▪ Approximately 5 houses would be potentially directly affected. ▪ Impacts on approximately 115 ha of prime agricultural land, mainly north of Brooms Head Road. ▪ High impacts on productive areas of Pine Brush State Forest. ▪ Potential impacts on rural communities around Pillar Valley, Bostock Road, Gulmarrad and James Creek Road. ▪ Impacts on the SEPP 14 wetland could require separate development approval.
Heritage	<ul style="list-style-type: none"> ▪ Overall heritage impacts would be moderate to high. ▪ Potential direct impacts on one site each of high and moderate historic significance, and five Aboriginal sites of low significance. ▪ Potential indirect impacts on two historic sites of high significance and one Aboriginal site of moderate significance.
Noise	<ul style="list-style-type: none"> ▪ Approximately 35 dwellings would be affected by noise levels in excess of the DEC criteria for night time noise, for new roads, including approximately 5 houses potentially directly affected by the road corridor.
Visual	<ul style="list-style-type: none"> ▪ Visual impacts through bushland and rural areas would be relatively high as a result of major new road infrastructure in areas that are currently characterised by a lack of development and human modification. However, low population density would reduce the severity of these impacts. ▪ Some areas would require large cuts and fills which have the potential to be visually prominent. ▪ Impacts in bushland areas would be mitigated to a degree by topography and shielding by vegetation. ▪ Would not provide a variety of visual experience for road users. ▪ Sections of the Green/C option around Gulmarrad and James Creek are relatively close to rural residential development and therefore have moderate to high visual impacts in these areas.

The Green/C option would be an entirely new road corridor, from Wells Crossing to Harwood Bridge. The main impacts associated with the Green/C option would relate to the construction of this new corridor through areas that are generally remote from major urbanisation and infrastructure and retain a rural and bushland character.

In the context of the study area, a new route corridor provides some strategic advantages in addressing the Pacific Highway Upgrade Program objectives, in particular:

- Achievement of significant travel time and transport cost savings for through traffic.
- A direct route for through traffic, which would also separate through and local traffic, enabling the existing highway to be utilised as a high standard dedicated local access road.
- A moderate reduction in the number of accidents overall in the transport corridor as a result of the high standard of the new road and reduction in traffic volumes (particularly heavy vehicles) on the existing highway.
- Provision of a relatively flood free route as an alternative to the existing Pacific Highway, which is highly flood affected.

- Minimising impacts on local communities by avoidance of further impacts on more densely settled urban areas in the west of the study area.
- A minor reduction in daytime noise impacts for properties along the existing highway, and a significant reduction in night time noise impacts along the existing highway as a result of heavy vehicles using the new road.

However, the creation of a new road corridor would result in impacts associated with major new infrastructure passing through rural communities, but providing them with little direct benefit. The Green/C option does not perform well in relation to the environmental objectives of the Pacific Highway Upgrade Program, or in terms of impacts to communities that are currently not affected by major roads. The main impacts in this regard include:

- Impacts on areas of ecological value, including additional severance of habitat links and corridors, and areas of remnant vegetation that are contiguous throughout the east of the study area.
- Severance of rural properties and new noise and visual affectation in areas that are currently not exposed to impacts from major infrastructure.

7.5 Assessment of the Red/D option

The Red/D option is the most easterly of the options. It deviates from the existing highway at Bald Knob Road, just north of Wells Crossing, and generally follows the eastern edge of the study area. It is located generally east of the Pillar Range and runs to the east of Pine Brush State Forest and the SEPP 14 wetlands north of the forest. In the north, the Red/D option is located east of Gulmarrad, Townsend and James Creek. It rejoins the existing highway alignment at the southern end of the existing Harwood Bridge.

This option is approximately 60 kilometres long, crosses nine kilometres of flood plain and is completely separate from the existing highway. Within the floodplain, it would provide at least one carriageway above the 1 in 20 year flood level. Bridges would be provided at Coldstream River, Chaffin Creek and other minor creeks. The preliminary cost of the Red/D option is between \$700 and \$800 million in 2005 dollars.

7.5.1 Functional considerations

Traffic volumes, travel time and costs

The Red/D option offers no opportunities for staged construction as it does not intersect with the existing highway at any intermediate locations.

The Red/D option would provide significant benefits to through traffic in terms of travel time and distance savings. It is approximately 12.5 kilometres shorter than the existing Pacific Highway.

The travel time saving for through traffic would be approximately 13 minutes, assuming a constant travel speed of 110 km/h.

The Red/D option would provide limited benefits to local traffic because it is located some distance from Grafton. Traffic making local trips within the study area would achieve little benefit in terms of travel time or cost savings compared to continuing to use the existing highway. It is therefore expected that only through traffic would utilise the Red/D option. This would mean that approximately 65-70 per cent of total traffic in the corridor, and 50 per cent of heavy vehicles, would continue to use the Pacific Highway rather than the Red/D option.

Safety

The Red/D option would be designed to achieve the RTA's accident rate standard of 15 accidents per 100 MVKT. Traffic travelling on the new route would therefore benefit from improved road safety. Approximately 65-70 per cent of traffic would remain on the existing highway, and this traffic would benefit from a reduction in overall traffic volumes, and a significant reduction in heavy vehicle volumes. These factors are expected to contribute to some improvement in safety on the existing Pacific Highway, including a minor reduction in the number and severity of accidents.

Relationship to the local road network

The Red/D option does not generally follow existing roads and has less potential to affect existing access to property. The need for service roads would therefore be expected to be minimal. Where necessary, service roads or alternative access routes would be provided in order to maintain access to properties and local roads. It is not expected that crossings (underpasses or overpasses) would be provided for all local roads crossed by the proposed alignment. Rather, the overall local road network would be reviewed and crossing points established based on road use and availability of practical alternative routes.

Where properties are split by the proposed upgrade, access would be provided across the new alignment to ensure land owners can access all parts of their property.

The actual location of interchanges would be subject to further assessment of travel demand in and around the study area. Interchanges may be located at Wells Crossing, to provide access to and from Grafton, and south of the Harwood Bridge to provide access to Maclean and Yamba. There is limited potential for additional interchanges between these points, because the Red/D option would not cross roads that provide access to major population or employment centres. Current understanding of local traffic movements to coastal areas such as Brooms Head and Wooli/Minnie Water indicates that interchanges at Brooms Head Road and Wooli Road would not be justifiable. Interchanges at these locations would provide little benefit to other local traffic such as access to Grafton or Maclean.

7.5.2 Environmental considerations

Topography, geology and soils

Between Wells Crossing and the Pine Brush State Forest the Red/D option is located on a number of terrain units including Southern Shale Lowlands, Eastern Hills and Valley and Central Sandstone Ridge. The option then crosses a section of the Clarence River Floodplain soils for a distance of approximately 10 kilometres. Continuing north, it crosses another section of Eastern Hills and Valley materials and then the Clarence River Delta terrain unit, east and north of the Gulmarrad and James Creek areas.

As discussed in **Section 5.3.1**, the terrain units in the southern section of the Red/D option are well suited to the construction of roads. Materials from cuttings would be of reasonable quality although they are not expected to be suitable for select fill.

The terrain within the Clarence River Floodplain and Clarence River Delta soils is low lying and construction of the Red/D option through these areas would require significant amounts of imported fill in order to achieve the required flood immunity for the project. The depth of the Clarence River Floodplain soils along the Red/D option is expected to be in the order of 10 to 15 metres. The Red/D option traverses these soils for a relatively short distance.

In the southern sections of the Red/D option, the likelihood of finding acid sulphate soils is low. The potential for acid sulphate soils through the Clarence River Floodplain and Clarence River Delta Soils is high.

Drainage and flooding

The alignment of the Red/D option avoids the majority of the Clarence River floodplain with the exception of approximately nine kilometres at the northern end. The alignment of the Red/D option is such that it would also need to be designed with consideration for the flow of floodwaters along some sections, including through the valley between the Pillar Range and Coastal Range. It is noted that although the option crosses a section of soils east of the Pine Brush State Forest classified as Clarence River Floodplain, this area does not have still floodwaters during the 100 year flood event, rather the water is moving through this area. Flood velocity, rather than inundation duration, is therefore a key consideration in this area.

Where the alignment is within the floodplain, fill materials would be required in order to produce a flood immunity for one carriageway for the 1 in 20 year event. Embankments would be typically two to three metres high, and up to four metres high in some sections of the floodplain.

The Red/D option would require between six to eight floodplain bridges, with another 25-30 required for creek crossings. Overall the cost of the bridges would be similar to the Green/C

option, a little less than the Purple/B option and significantly less than the Orange/A option. Numerous other culverts would be required.

Water quality

The Red/D option would cross the upstream reaches of Coldstream River and Chaffin Creek, Pillar Valley Creek and Amos Creek. South-east of Harwood the Red/D option crosses an unnamed tributary near the Clarence River at Harwood. Key findings of the water quality assessment, based on sampling to date, are:

- The upstream reaches of Coldstream River had very low dissolved oxygen levels and does not comply with the ANZECC/ARMCANZ (2000) guidelines.
- Chaffin Creek has poor water quality, indicated by dissolved oxygen levels below the ANZECC/ARMCANZ (2000) guidelines, and high turbidity levels.
- The water quality of Pillar Valley Creek varied between sites, with high turbidity (exceeding the ANZECC/ARMCANZ (2000) guidelines), and low dissolved oxygen (below the guideline levels).
- The unnamed tributary of the Clarence River and the Clarence River itself met the ANZECC/ARMCANZ (2000) guidelines for the protection of aquatic ecosystems.

Ecology

Table 7-16 summarises the key ecological impacts of the Red/D option based on a nominal road reserve width of 100 metres. Overall, the Red/D option is considered to have a relatively high ecological impact compared to other options. The main impacts are on remnant vegetation, high quality flora and fauna habitat, and aquatic habitats that, in the context of the study area, have a relatively high value.

Table 7-16 Ecological impacts of the Red/D option

National Parks	SEPP Wetlands	State Forests	EECs	High value habitat
Nil	Nil	7.2 ha	24.3 ha	220 ha

The forests in the vicinity of the Red/D option are contiguous with and similar in quality to those in the Yuraygir National Park and as such provide significant opportunities for wildlife movement. Habitat linking the Coast Range to Shark Creek Range would be intersected by the Red/D option. While in some areas the Red/D option passes through cleared grazing land, the overall impacts on habitat corridors would remain substantial, particularly for species such as the coastal Emu, which utilises both cleared and forested habitats. The coastal Emu population is frequently recorded around the Gulmarrad area and has been sighted on numerous occasions by members of the study team around Taloumbi and Red Root Road.

The aquatic habitat impacts of the Red/D option would also be similar to the Green/C option, described in **Section 7.4.2**. The Red/D option would require waterway crossings at Coldstream River, Pillar Valley Creek, Chaffin Creek, Boundary Creek and Shark Creek. The option traverses the majority of these waterways in their upper reaches, which exhibit relatively high aquatic habitat values.

7.5.3 Social considerations

Planning and land use

Table 7-17 summarises the key land use and planning impacts of the Red/D option, based on the assessment criteria developed for the project.

Table 7-17 Land use impacts of the Red/D option

Criteria	Impacts
Approximate number of houses within route corridor (200 metre wide corridor).	10 houses
Area of urban/ village zoned land within route corridor.	Nil
Area of urban investigation zoned land within route corridor.	Nil
Area of rural residential or rural small holdings zoned land within route corridor.	Nil
Area of State Forest management zone 4, 5 or 6 land within route corridor.	32 ha
Direct impact on national parks estate lands.	Nil
Direct impacts on SEPP 14 wetlands.	Nil
Direct impacts on forest management zones 1, 2 and 3A.	7.2 ha
Impacts on productive agricultural land (land classification levels 1-3).	222 ha

Note: impacts are based on a 100 metre wide corridor unless otherwise stated.

Overall, the impacts of the Red/D option on land use and planning are assessed to be relatively low. It passes through areas where the intensity of rural land use is lower than other parts of the study area, with the exception of north of Brooms Head Road, where rural land use impacts would be more substantial. The other main impact of the Red/D option is around Pillar Valley, where rural residences would be indirectly or directly affected, along with activities such as grazing.

The main impacts of the Red/D option on land use include:

- Impacts on rural residences around Pillar Valley, Taloumbi and James Creek.
- Impacts on grazing and cane farming around Taloumbi and east of James Creek.
- Impacts on grazing land around Red Root Road, east of Pine Brush State Forest.
- Minor impacts on other rural residences and private property containing a mix of grazing and remnant bushland for much of its length.
- Impacts on Glenugie State Forest including direct take of productive forested land and severance impacts on forestry operations.

As with other options, the permissibility of the Red/D option under Ulmarra LEP 1992 requires confirmation through further consultation with Clarence Valley Council and planning action may be required to ensure the project can be assessed as development without consent.

Indigenous and non-indigenous heritage

The Red/D option has the potential to impact directly on two historic sites and three Aboriginal sites. A site complex may also be indirectly affected by the Red/D option.

The same topographies and environments as for the Green/C option are crossed in the southern half of this alignment and therefore the route has a similar potential to impact on unrecorded sites. The northern section of this option crosses the floodplain and some swampy ground, which has lower potential for Aboriginal sites.

The Red/D option does not pass through established towns. The potential for impact on unrecorded, but significant non-indigenous sites is therefore considered to be limited.

Table 7-18 provides a summary of the potential heritage impacts of the Red/D option. Overall, the potential for heritage impacts from this option is assessed to be low.

Table 7-18 Heritage impacts summary for the Red/D option

Option	Sites Directly Impacted Significance			Sites Indirectly Impacted Significance			Impact Rating
	High	Moderate	Low	High	Moderate	Low	
Red/D	-	-	3 indigenous sites	2 indigenous sites	1 indigenous site	-	Low

Noise impacts

The number of residences predicted to experience noise levels within various ranges has been estimated in **Table 7-19**, based on noise modelling undertaken for the route options, and assuming noise impacts are unmitigated. These ranges relate to the base noise criteria outlined in **Section 5.4.7** for both day and night time periods for a new road as well as a redeveloped road. The upper and lower ranges of > 65 dB(A) and < 45 dB(A) include dwellings that would experience levels greater than the base criteria and less than the base criteria respectively.

Based on the modelling results, the Red/D option has the least potential for noise impacts overall, and very low potential for exceedence of the noise criteria for new roads. The main areas of likely noise affectation for the Red/D option, including potential exceedence of the criteria, are:

- Around Pillar Valley in the south, where residences fronting Wooli Road are within close proximity to this option.

- Residences around Brooms Head road west of Taloumbi.
- Residences in the vicinity of James Creek Road in the north.

Table 7-19: Noise assessment of the Red/D option

Noise Level Range L_{Aeq} dB(A)	No. of affected residences	
	Day	Night
>45 and ≤ 50	55	50
>50 and ≤ 55	20	25
>55 and ≤ 60	5	5
>60 and ≤ 65	5	5
> 65	5	5
Total	90	90

Notes:

Numbers of affected residences have been rounded up to the nearest 5, to account for the broad level assessment at this stage of the project.



Denotes residences where the criteria for a new road are potentially exceeded



Denotes residences where the criteria for a redeveloped road are potentially exceeded

Visual impacts

Overall, the visual impacts of the Red/D option are assessed to be relatively high. The Red/D option would be an entirely new road corridor, and for much of its length would pass through areas that have not historically been subject to a high degree of modification as a result of human activity. However, existing bushland and topography create some opportunities to shield this option from view from surrounding areas. The main visual impacts of the Red/D option are:

- Large cuts and fills through areas of high relief terrain, resulting in a large road footprint in some locations and significant clearing of remnant vegetation.
- Potential impacts around Pillar Valley at the crossing of Woolli Road where the Green/C option has the potential to become a significant feature in an otherwise rural and bushland environment.
- To the east of Gulmarrad and James Creek where the Red/D option would impact on the dominant visual character of the floodplain and cane farming areas.

Vegetation along the Red/D option is typically forested lands which provide a sense of enclosure and would screen the option from view from surrounding properties and local roads. Consequently, there are limited opportunities to view the proposal and the alignment has a low visual sensitivity in these environments. The Red/D option also has the advantage of being located in relatively undeveloped areas, where population density is low so less people would be exposed to the road.

In the north, from Brooms Head to Harwood Bridge, the Red/D option enters the intensively cultivated floodplain of the Clarence River. The predominant visual character of this area is sugar

cane farming, a unique landscape setting characteristic of the north coast. The topography of this alignment is generally low lying and the road would be elevated to address flooding issues. While this formation has the potential to be highly visible the alignment is generally removed from population areas and would not be overlooked. Consequently the road in this section would have a low visual impact.

7.5.4 Summary of the Red/D option

Table 7-20 provides a summary of the impacts of the Red/D option.

Table 7-20 Summary assessment of the Red/D option

Criteria	Assessment of the Red/D option
Road safety	<ul style="list-style-type: none"> ▪ Can be designed to achieve the target crash rate of 15 crashes per 100 million vehicle kilometres travelled, halving the crash rate for traffic using the new road. ▪ Some improvement in traffic safety for traffic using the existing highway from reductions in traffic volumes and heavy vehicle volumes on the existing highway.
Traffic, transport and access	<ul style="list-style-type: none"> ▪ Would attract minimal volumes of local traffic from the existing highway. ▪ Approximately 30-35% of vehicles are through traffic and would use the Red/D option. ▪ Approximately 50% of heavy vehicles are through traffic and would use the Red/D option. ▪ Approximately 75% of heavy vehicles are semi-trailers or B-Doubles and approximately 60% of these are through traffic that would use the Green/C option rather than the existing highway. ▪ The travel time saving for through traffic between Wells Crossing and Harwood Bridge would be approximately 13 minutes. ▪ Potential interchange locations include Bald Knob Road and south of Harwood Bridge.
Engineering	<ul style="list-style-type: none"> ▪ Would be designed to achieve the standards required for the Pacific Highway Upgrade Program, including 110km/h design speed. ▪ No opportunities for staged construction. ▪ Cost estimate of between \$700-800 million (in 2005 dollars).
Topography, geology and soils	<ul style="list-style-type: none"> ▪ Generally topography and soils present minimal constraints. ▪ Areas of floodplain soils would be traversed around Red Root Road and north of Brooms Head Road - some potential to encounter soft soils and acid sulphate soils. ▪ Earthworks volumes would be significant, but cut and fill volumes would be balanced.
Drainage and flooding	<ul style="list-style-type: none"> ▪ Approximately nine kilometres of this option would be within the floodplain, around Red Root Road and north of Brooms Head Road. ▪ High flood flow velocities exist in floodplain areas around Red Root Road. ▪ Embankments would be typically two to three metres high, and up to four metres high in some sections of the floodplain. ▪ Between six and eight floodplain bridges would be required, plus another 25 to 30 bridges across creeks outside the floodplain.
Water quality	<ul style="list-style-type: none"> ▪ Water quality is generally good in the vicinity of this option, with the exception of low dissolved oxygen and high turbidity in some locations.
Ecology	<ul style="list-style-type: none"> ▪ Ecological impacts of this option would be high. ▪ High potential for impacts on high value fauna habitat and fauna corridors for approximately 22 kilometres of this option, in particular around Pillar Valley, east of Pine Brush State Forest, and around Brooms Head Road. ▪ Impacts on identified habitat links between high ecological value areas within the Pine Brush State Forest.

Criteria	Assessment of the Red/D option
Planning and land use	<ul style="list-style-type: none"> ▪ Approximately 10 houses would be potentially directly affected. ▪ Impacts on approximately 220 ha of prime agricultural land, mainly north of Brooms Head Road and around Red Root Road. ▪ Potential impacts on rural communities around Pillar Valley, Bostock Road and James Creek Road. ▪ Minor impacts on Glenugie State Forest and grazing land in the south of this option.
Heritage	<ul style="list-style-type: none"> ▪ Overall heritage impacts would be low. ▪ Potential direct impacts on three Aboriginal sites of low significance. ▪ Potential indirect impacts on two Aboriginal sites of high significance and one Aboriginal site of moderate significance.
Noise	<ul style="list-style-type: none"> ▪ Approximately 40 dwellings would be affected by noise levels in excess of the DEC criteria for night-time noise, for new roads, including approximately 10 houses potentially directly affected by the road corridor.
Visual	<ul style="list-style-type: none"> ▪ Southern and middle sections traverse forested terrain, free from development and therefore have low visual impact. ▪ Alignment does not provide a variety of experience for road users. ▪ Approach to Clarence River crossing traverses sugar cane growing region and would result in visual fragmentation of this strong landscape unit.

The Red/D option would be an entirely new road corridor from Wells Crossing to Harwood Bridge. The main impacts of the Red/D option would relate to the construction of a new road corridor through areas generally remote from major urbanisation and infrastructure that retain a rural and bushland character.

In the context of the study area, a new route corridor provides some strategic advantages that can contribute to the achievement of the Pacific Highway Upgrade Program objectives, in particular:

- Achievement of significant travel time and transport cost savings for through traffic.
- A direct route for through traffic, which would also separate through and local traffic, enabling the existing highway to be utilised as a high standard dedicated local access road.
- A moderate reduction in the number of accidents overall in the transport corridor as a result of the high standard of the new road and reduction in traffic volumes (particularly heavy vehicles) on the existing highway.
- Provision of a relatively flood free route as an alternative to the existing Pacific Highway, which is highly flood affected.
- Avoidance of further impacts on more densely settled urban areas in the west of the study area.
- A minor reduction in daytime noise impacts for properties along the existing highway, and a significant reduction in night time noise impacts on the existing highway as a result of reductions in heavy vehicle volumes.

The creation of a new road corridor would result in impacts associated with major new infrastructure passing through, but providing little direct benefit to, rural communities. The Red/D

option performs poorly in relation to the ecological and community objectives of the Pacific Highway Upgrade Program, as a result of the following impacts:

- Severance of rural properties and new noise and visual affectation in areas that are currently not exposed to impacts from major infrastructure.
- Creation of additional impacts on areas of ecological value including additional severance of habitat links and corridors, and areas of remnant vegetation that are contiguous throughout the east of the study area.

7.6 Potential connections between options

Two potential connections between route options have also been identified for assessment. These are:

- Between the Purple/B and Orange/A options to the south and east of Tyndale.
- Between the Green/C or Red/D options and the Purple/B option in the vicinity of Shark Creek.

These connections enable sections of the route options to be combined to provide route options that may better meet the objectives of the project. The impacts of these potential connections have been assessed separately to the main route options.

The connection between the Purple/B and Orange/A options is located near Tyndale and allows for the use of the Purple/B option south of Tyndale and the Orange/A option (existing highway alignment) north of Tyndale. The connection is approximately five kilometres long, has a generally north-south alignment and passes to the east of the village of Tyndale.

The connection between the Green/C or Red/D options and the Purple/B option is up to 9.5 kilometres long, depending on whether it connects from the Red/D or Green/C options. It allows the eastern options to connect with the existing highway corridor west of Gulmarrad and Townsend rather than passing to the east of these towns. The connection crosses the Shark Creek Range before crossing the floodplain around Shark Creek closer to the existing highway. The connection has been located as far south as practical in order to minimise potential impacts on the rural residential developments in Townsend and Gulmarrad. Local road access in this area would be maintained using either underpasses or overpasses, where roads cross the route of this potential connection.

Topography, geology and soils

The Tyndale connection is located on Central Sandstone Ridge materials. This terrain unit presents reasonable construction conditions although some seams may be difficult to rip and need blasting. Materials from cuttings would be of good quality with some materials from the stronger sandstones suitable for select fill. The likelihood of acid sulphate soils through the Central Sandstone Ridge soils is low.

The Shark Creek connection is located across the Eastern Hills and Valley terrain unit, and Clarence River Floodplain terrain unit. As previously discussed, the Eastern Hills and Valley terrain unit presents reasonable conditions for construction, while the Clarence River Floodplain terrain unit is constrained by soft soils and potential acid sulphate soils.

Drainage and flooding

The Tyndale connection is not impacted by flooding as it is located out of the floodplain on the slopes of the Pillar Range. Drainage requirements are likely to include a number culverts and small bridges for cross drainage from the range to the floodplain.

The western section of the Shark Creek connection is located on the Clarence River Floodplain. In this section imported fill materials would be required to produce a flood immunity for one carriageway for the 1 in 20 year event. Embankments would be typically four metres high, but up to six metres high in some locations through the floodplain.

Water quality

The potential connection at Tyndale does not cross any waterways and as such is assessed to have a low potential for impacts on water quality in the study area.

The potential connection at Shark Creek crosses Shark Creek. As previously discussed the water quality of Shark Creek complies downstream of the connection, however, upstream water quality had dissolved oxygen and pH below recommended trigger values for protection of estuarine ecosystems.

Ecology

The ecological impacts of the Tyndale connection would be similar to those described for the Purple/B option in this area. The potential connection would have less impact in terms of severance of habitat corridors since it is located more towards the fringe of remnant vegetation areas. It would impact on vegetation on the lower hill slopes of the Shark Creek Range around Bondi Hill, to the south and east of Tyndale. This area is unlikely to contain vegetation communities that are representative of endangered ecological communities in the study area. There are no major waterway crossings for this potential connection.

The Shark Creek connection passes through a mix of vegetation communities and habitat conditions, including the drier forests of the low to upper slopes and ridges of the Shark Creek Range, and floodplain vegetation communities to the north of the Shark Creek SEPP 14 wetland.

The eastern half of this connection generally passes through vegetation communities similar to those described in this area for the Red/D and Green/C options (see **Section 7.4.2**), and would be expected to have impacts on important habitat areas, including relatively high quality remnant vegetation and habitat corridors. The western section of this option crosses cane fields with low habitat values. This potential connection would cross Shark Creek at two locations. In both these locations the habitat values of the creek have been reduced by clearing of the riparian zone and water quality has been impacted by adjacent agricultural land uses.

Planning and land use

The potential connection at Tyndale passes through general agriculture zoned land that contains remnant bushland. It would have only minor impacts on rural land use. It has the potential to impact directly and indirectly on residences in and around Tyndale, particularly to the south and east of the village.

The potential connection at Shark Creek passes generally through land zoned for general agriculture and containing remnant bushland on private land. It has been aligned to avoid impacts on environment protection zoned lands within the Shark Creek Range. It would impact on prime agriculture land containing cane farms around Shark Creek.

The potential connections are entirely within land covered by Maclean LEP. No direct impacts on SEPP 14 wetlands or national parks estate lands would occur. The connections would be permissible without consent, by operation of SEPP 4.

Indigenous and non-indigenous heritage

The connection from the Purple/B route to the Orange/A route near Tyndale has the potential to impact directly on the three houses incorporated within a non-indigenous site identified under the Maclean LEP. No indigenous heritage items have been identified in the vicinity of this potential connection to date.

The connection in the vicinity of Shark Creek has been assessed to have a low potential for impacts on indigenous and non-indigenous heritage. No sites have been identified within the vicinity of this connection in investigations to date.

Noise impacts

Residences along Coldstream Road would be impacted by increased noise levels from the potential connection at Tyndale. In addition, several residences south of Tyndale would experience a new noise exposure. Re-alignment of this connection further to the east, subject to other constraints, would reduce the noise impacts on nearby residences.

The potential connection at Shark Creek provides a good noise buffer to residences between the Red/D and Purple/B options. The nearest residence is approximately 600m away. Where the connection joins the Purple/B option at Shark Creek noise impacts would be as assessed for the Purple/B option.

7.7 Harwood to Iluka Road section

The Harwood to Iluka Road section involves upgrading generally adjacent to the existing highway alignment. Some modifications to the existing highway alignment would also be needed to achieve required design standards. The Harwood to Iluka Road section is approximately 10.5 kilometres long, including potential intersection and approach works that may extend to the north of the existing Iluka Road intersection. An interchange would be located at the Iluka Road intersection. At least one carriageway would be above the 1 in 20 year flood level.

For the Class M standard road, two new two-lane bridges would be provided across the Clarence River, and one new two lane bridge at the North Arm. This would require two new carriageways to be constructed adjacent to the existing highway, except in sections that are currently dual carriageway. North of approximately Carroll Lane (on Chatsworth Island) to just south of Iluka Road, the existing highway is dual carriageway, and the upgrade would involve widening to create one additional two-lane carriageway. The existing highway would operate as a local service road and alternative route, ensuring access to local communities is maintained.

The preliminary cost of the Harwood to Iluka Road section is between \$400 and \$450 million in 2005 dollars.

7.7.1 Functional considerations

Traffic volumes, travel time and costs

The section between Harwood and Iluka Road offers limited opportunities for staged construction. Given that it is relatively short, staging is not a major issue for this section of the project. Staging may be achieved through initial development of this section to Class A standard, with later development to a full Class M as traffic demand requires it.

As it would follow the general alignment of the existing highway, the upgrade would offer little benefit in terms of travel time and distance savings. The construction of a new bridge over the

Clarence River would be at a sufficient height to ensure it does not need to be opened to allow boats to pass along the river. This would result in improved travel time for traffic on the new route. The actual required clearance height would be determined through consultation with Maritime NSW, with consideration of known and likely future boat traffic using the Clarence River.

In the initial stages of development, this section of the project may be developed to Class A standard, allowing for some intersections with other roads at grade. All traffic that currently uses the highway would use the upgraded road. Under the ultimate development scenario for this section of the highway (two new carriageways and a Class M standard) some separation of local and through traffic would be expected, although it is expected that only traffic accessing destinations on Harwood or Chatsworth Islands would continue to use the existing highway.

Safety

The upgrade between Harwood Bridge and Iluka Road would be designed to achieve the RTA's accident rate standard of 15 accidents per 100 MVKT. The majority of traffic would travel on the new route and would therefore benefit from improved road safety.

Relationship to the local road network

Intersections with the existing highway are currently located at a number of points along this section of the road including Watts Lane, Carroll Lane, Chatsworth Road and Iluka Road. For a Class A standard road, intersections with the highway would be limited to key locations to minimise conflicts between through traffic and local traffic. Service roads may be required in some locations to ensure that local access is maintained. The exact details of service road requirements are yet to be determined and would be subject to further development at the concept design stage of the project.

For a Class M standard upgrade the existing highway would operate as a local service road or alternative route for the entire length between Harwood Bridge and Iluka Road. Two new carriageways would be constructed to accommodate through traffic separate to local traffic on the existing highway. Local roads would continue to intersect with the existing highway. Grade separated crossings would be provided to ensure traffic can continue to move across the upgraded highway. In particular, consideration would be given to the need to maintain access to the Harwood sugar mill by cane trucks.

The exact location of interchanges is yet to be determined, although interchanges may be required south of Harwood Bridge and at Iluka Road. These interchanges would provide opportunities for local traffic to access the upgraded highway.

7.7.2 Environmental considerations

Topography, geology and soils

The Harwood to Iluka Road section of the project is located on Clarence River Delta soils, which are low lying and require significant amounts of imported fill to achieve the required design levels. These conditions are likely to present difficulties of soft foundations and potentially high rates of settlement that would require either a long period of pre-loading or alternative treatments such as installation of wick drains to accelerate the process. The potential for acid sulphate soils through the Clarence River Floodplain and Clarence River Delta Soils is high although this would not greatly effect construction as is the road would be predominantly constructed on fill.

Drainage and flooding

The Harwood to Iluka Road section of the project is located entirely within the Clarence River floodplain with the majority of the length being located on the Harwood and Chatsworth Islands, between the Clarence River and the North Arm. As well as major bridges across the Clarence River, North Arm and Serpentine Channel, an additional six to eight floodplain bridges would be required as well as various smaller culverts. Embankments would be typically two to three metres high across the floodplain in order to produce flood immunity for one carriageway for the 1 in 20 year event.

The design of the upgrade within farming areas (particularly cane farms) would need to consider potential impacts of changes to the flooding regime including flood levels, inundation times and flow paths. The design of the upgrade would include significant floodplain bridges and/or culverts to allow for the passing of the flood waters with minimal impact on the levels or inundation times. However, some change in the flow paths would result due to the need to direct floodwaters to specific openings rather than allowing the water to spill over the full length of the highway, as currently occurs. The flood openings are expected to be located at existing low points in the alignment, which would result in minimal changes to overall flow patterns.

Water quality

The existing Pacific Highway crosses the mainstream Clarence River, Serpentine Channel and North Arm at the northern section of the study area. Dissolved oxygen and pH at sites 1, 2, 3 and 4 was generally within the ANZECC/ARMCANZ (2000) guidelines for estuarine ecosystems. Turbidity at these sites was high, exceeding or equal to the trigger value of 10NTU.

Ecology

This section generally traverses a highly modified environment, primarily consisting of cane farms. The potential for ecological impacts is minimal. Remnant mangrove areas are located in narrow bands along the banks of the Clarence River, Serpentine Channel and North Arm, and would be impacted by additional bridge structures. Mangrove remnants are patchy on the northern bank of

the Clarence River at Harwood, and impacts would be minimal. The Serpentine Channel contains a more continuous band of mangroves and other riparian vegetation, albeit in narrow strips along both banks. These would be impacted by an additional bridge structure in this location. An additional crossing of the North Arm at Mororo would potentially impact on patchy remnant mangroves on both banks of the North Arm.

Small areas of remnant native vegetation are present along the section north of the North Arm of the Clarence River. This includes small patches of Swamp Sclerophyll Forest and Subtropical Coastal Floodplain Forest in the vicinity of the Iluka Road turnoff. These areas contain some limited habitat for threatened species, and may be impacted by interchange structures.

7.7.3 Social considerations

Planning and land use

Table 7-21 summarises the key land use and planning impacts of the project between Harwood and Iluka Road, based on the assessment criteria developed for the project. The impacts of an upgrade either to the east or west of the existing highway alignment have been assessed.

Table 7-21 Land use impacts between Harwood and Iluka Road

Criteria	Eastern option	Western option
Number of houses within route corridor (200 metre wide corridor).	21 houses	23 houses
Area of urban/ village zoned land within route corridor.	1 ha	1.8 ha
Area of urban investigation zoned land within route corridor.	0.2 ha	Nil
Area of rural residential or rural small holdings zoned land within route corridor.	Nil	Nil
Area of State Forest management zone 4, 5 or 6 land within route corridor.	Nil	Nil
Direct impact on national parks estate lands.	Nil	Nil
Direct impacts on SEPP 14 wetlands.	Nil	Nil
Direct impacts on forest management zones 1, 2 and 3A.	Nil	Nil
Impacts on productive agricultural land (land classification levels 1-3).	95 ha	95 ha

Note: impacts are based on a 100 metre wide corridor unless otherwise stated.

Overall, the land use impacts of the project between Harwood Bridge and Iluka Road would be minimised as a result of widening the existing road corridor rather than creation of a new route. The main land use impacts of the project in the section between Harwood Bridge and Iluka Road would be on cane farms and the village of Harwood. Upgrading to the west of the existing highway would have a greater impact on Harwood than upgrading to the east, due to impacts on Harwood Island Public School and houses. The interchange at Iluka Road has the potential to impact on some ecological values and rural residential areas.

Care is required in considering the design of the Iluka Road interchange to ensure that the Mororo Creek Nature Reserve is not impacted.

Indigenous and non-indigenous heritage

The assessment of heritage impacts for the upgrade between Harwood Bridge and Iluka Road concluded that:

- One indigenous heritage item was recorded during field surveys: an artefact scatter located on a track at the edge of Mororo Creek, which is unlikely to be affected by the options.
- Within Harwood potential indirect impacts on non-indigenous heritage sites include the town itself, the school and residence on Morpeth Street, and a residence on River Street listed under Maclean LEP.
- A site listed under the Maclean LEP, a former boat ramp located west of Mororo Bridge, on the southern side of the North Arm, is unlikely to be affected by the project.

Noise impacts



The number of dwellings predicted to experience noise within a range of levels has been estimated in **Table 7-22**, based on noise modelling undertaken for the route options, and assuming noise impacts are unmitigated. As with land use impacts, the noise impacts of upgrading either to the east or west of the existing highway have been assessed to allow for comparative assessment of impacts of options within the corridor. The ranges relate to the base noise criteria outlined in **Section 5.4.7** for both day and night time periods for a new road as well as a redeveloped road. The upper and lower ranges of > 65 dB(A) and < 45 dB(A) include dwellings that would experience levels greater than the base criteria and less than the base criteria respectively.

Table 7-22: Noise assessment of route options between Harwood and Iluka Road

Noise Level Range L _{Aeq} dB(A)	No. of affected residences			
	Eastern option		Western option	
	Day	Night	Day	Night
>45 and ≤ 50	10	20	10	25
>50 and ≤ 55	45	55	35	35
>55 and ≤ 60	40	20	50	45
>60 and ≤ 65	15	15	15	10
>65	5	0	5	5
Total	115	110	115	120

Notes:

Numbers of affected residences have been rounded up to the nearest 5, to account for the broad level assessment at this stage of the project.

-  Denotes residences where the criteria for a new road are potentially exceeded
-  Denotes residences where the criteria for a redeveloped road are potentially exceeded

The criteria for a redeveloped road are likely to be most relevant for this section of the project, as it would involve duplication of the existing alignment. The majority of affected residences would be within Harwood village itself as settlement along the highway further north is very sparse.

Upgrading to the west of the existing highway would result in a greater number of residences where night time noise criteria would be exceeded compared to upgrading to the east of the existing alignment.

Visual impacts

The visual environment in this area is characterised by sugar cane farms which provide strong definition to the existing highway alignment. The upgraded road would be raised on embankments to address flooding issues. The treatment of the batters of this embankment will be critical in achieving integration of the road. The road corridor would also be substantially widened in some sections increasing the visual presence of the road through the relatively low lying and flat terrain.

A critical issue for this section of the project is the crossing of the Clarence River. Presently an historic truss bridge with lifting span crosses the river. The upgrading of the highway will require the introduction of either one or two new bridge structures parallel to the existing bridge. The most significant impact would be on Harwood village which would be more fragmented as a result of the widened road reserve through the town as well as direct impacts to properties.

Discussions are continuing with Maritime NSW as to the clearance requirements for new bridge crossings over the Clarence River. The final clearance height to be adopted will affect the overall length of the bridge. Initial designs for this bridge range from a 700 metre long structure to provide 18 metre clearance over the river to a 1600 metre long structure to provide 36 metre clearance.

Heritage and urban design issues are important in determining the final alignment and design of bridges and embankments. Issues that need to be addressed include the appearance of the existing and new bridges side by side and height differences.

7.7.4 Summary of the options between Harwood and Iluka Road

As options in this section of the project are limited to a new road adjacent to the existing Pacific Highway, impacts are limited to those associated with widening of the existing road corridor. In the ultimate configuration as a Class M road, this section would (for most of its length) require significant widening of the existing road reserve to allow for two new carriageways and operation of the existing highway as a local service road. This widening is likely to be restricted to the eastern side of the existing highway, particularly at Harwood village and Mororo Bridge, where substantial constraints limit widening to the west. **Table 7-23** summarises the impacts of the project between Harwood Bridge and Iluka Road.

Table 7-23 Summary assessment of the project between Harwood Bridge and Iluka Road

Criteria	Assessment of the upgrade between Harwood Bridge and Iluka Road
Road safety	<ul style="list-style-type: none"> Would be designed to achieve the target crash rate of 15 crashes per 100 million vehicle kilometres travelled, halving the crash rate for traffic using the new road. Substantial improvement in traffic safety for traffic using the existing highway.
Traffic, transport and access	<ul style="list-style-type: none"> Would be utilised by the majority of local and through traffic. Travel time saving would be small. Full interchange would be provided at Iluka Road, with other interchanges subject to traffic demand.
Engineering	<ul style="list-style-type: none"> Would be designed to achieve the standards required for the Pacific Highway Upgrade Program, including 110km/h design speed. Potential for staged construction initially to Class A, with full upgrade to Class M should demand require it. Preliminary cost estimate is \$400-450 million (in 2005 dollars).
Topography, geology and soils	<ul style="list-style-type: none"> Mostly located in compressible floodplain soils across Harwood and Chatsworth Islands. High potential to encounter soft soils and acid sulphate soils. Earthworks volumes would be significant, with large volumes of fill.
Drainage and flooding	<ul style="list-style-type: none"> Approximately ten kilometres of this section of the project would be within the floodplain across Harwood Island and Chatsworth Island. Embankments would typically be two to three metres high, but up to 4.5 metres high in some locations in the floodplain. Between six and eight floodplain bridges would be required, plus another three bridges across creeks outside the floodplain.
Water quality	<ul style="list-style-type: none"> Water quality is generally good in the Clarence River and North Arm.
Ecology	<ul style="list-style-type: none"> Ecological impacts of this option would be low. Some potential for impacts on remnant mangrove and saltmarsh communities and aquatic habitats at river and creek crossings.
Planning and land use	<ul style="list-style-type: none"> Approximately 21 houses would be potentially directly affected by an upgrade to the east of the existing highway, or 23 houses by upgrading to the west of the highway. Impacts on approximately 95 ha of prime agricultural land, mainly edge effects on cane farms. Potential impacts on Harwood village, which would be greater for the upgrade to the west of the existing highway.
Heritage	<ul style="list-style-type: none"> Overall heritage impacts would be low. Potential indirect impacts on the heritage values of sites within Harwood village including Harwood Island School and a house.
Noise	<ul style="list-style-type: none"> Based on upgrading to the east of the existing highway, approximately 35 dwellings would be affected by noise levels in excess of the DEC criteria for night-time noise, for new roads, including approximately 21 houses potentially directly affected by the road corridor. Based on upgrading to the west of the existing highway, approximately 60 dwellings would be affected by noise levels in excess of the DEC criteria for night-time noise, for new roads, including approximately 23 houses potentially directly affected by the road corridor.
Visual	<ul style="list-style-type: none"> Through Harwood Island and Chatsworth island the project traverses cane farms and would result in visual fragmentation of this strong landscape unit.

The main impacts associated with this section of the project are direct land take, mainly of cane farming land, and potential changes to flooding behaviour, which may include flood depths, flow velocities, inundation durations and flow paths. Indirect impacts such as noise have the potential to increase slightly as a result of widening of the road corridor bringing traffic closer to existing

residences. The new crossing of the Clarence River at Harwood would have potentially substantial visual impacts. However, the crossing also presents opportunities to enhance the visual identity of the highway through a structure that becomes a local landscape feature.

7.8 Comparative summary of the route options

To enable comparison of the impacts of the route options between Wells Crossing and Iluka Road, **Table 7-24** provides an overview of the assessment of each option against the criteria for the project.

Table 7-24 Comparative assessment of the route options between Wells Crossing and Iluka Road

	Orange/A option	Purple/B option	Green/C option	Red/D option
Traffic and transport considerations				
Road safety	All options achieve the target crash rate of 15 crashes per 100 MVKT.			
Road safety for users of existing highway	Would attract the majority of traffic from the existing highway.	Purple/B, Red/D and Green/C options achieve some improvement in traffic safety for traffic using the existing highway. Some improvement in safety for users of the existing highway would result from reduced traffic volumes, in particular reduced heavy vehicles.		
Attraction of heavy vehicles to the new road	The majority of heavy vehicles (including most of those with a destination in the study area) would use the Orange/A option rather than the existing highway.	Approximately half of all heavy vehicles, including approximately 60% of semi trailers and B-Doubles, are through traffic and would use the Purple/B, Green/C and Red/D options.		
Attraction of semi-trailers and B-Doubles to the new road	Approximately 75% of heavy vehicles are semi-trailers or B-Doubles and the majority of these would use the Orange/A option rather than the existing highway. Almost all heavy vehicles travelling at night would use the Orange/A option.	Approximately 75% of heavy vehicles are semi-trailers or B-Doubles and approximately 60% of these are through traffic that would use the Purple/B, Green/C or Red/D options rather than the existing highway. Almost all heavy vehicles travelling at night are through traffic and would use the Purple/B, Green/C and Red/D options. This would result in significant traffic volume reductions at night along the existing highway, as up to 70% of night time traffic is heavy vehicles.		
Potential savings in travel time between Wells Crossing and Harwood Bridge	8 minutes	10 minutes	13 minutes for Green/C and Red/D options	
Potential location of interchanges to access Grafton	Interchanges at Bom Bom and north of Swan Creek.	Interchange at Glenugie.	Southern interchange located near Bald Knob Road.	
Potential location of interchanges to access Maclean and Yamba	All options would have an interchange south of Harwood Bridge to provide access Maclean and Yamba.			

	Orange/A option	Purple/B option	Green/C option	Red/D option
Local road access	All options would provide for local access roads to go over or under the new road, so that local access routes are largely retained.			
Potential social and land use impacts				
Potential number of houses directly affected	175	35	5	10
Compatibility with zoning	All options are generally compatible with zoning. However, permissibility issues under Ulmarra LEP 1992 require resolution. All options have been designed to avoid impacting on future development potential in accordance with the Clarence Valley Settlement Strategy.			
Impacts on land use	Land use impacts mainly relate to widening of the existing highway.	Potential impacts on urban areas would be limited to indirect impacts through Townsend associated with widening of the existing highway.	Potential impacts on rural communities around Pillar Valley, Bostock Road, Gulmarrad and James Creek Road. Impacts on the SEPP 14 wetland would require development consent and would be designated development.	Potential impacts on rural communities around Pillar Valley, Bostock Road and James Creek Road. Some impacts on Glenugie State Forest and grazing land in the south of this option.
Impacts on rural properties	Severance impacts limited to between Bom Bom and Swan Creek, other impacts are reduced by following existing highway.	Purple/B, Green/C and Red/D options have the potential to sever some rural properties and may require measures to provide connectivity between severed properties.		
Impacts on agricultural land	Approximately 465 ha of prime agricultural land potentially affected, particularly between Bom Bom and Swan Creek. Edge effects on cane farms along existing highway corridor.	Approximately 265 ha of prime agricultural land, including grazing land around the Coldstream River and cane farms around Shark Creek.	Approximately 115 ha of prime agricultural land, mainly north of Brooms Head Road.	Approximately 220 ha of prime agricultural land, mainly north of Brooms Head Road and around Red Root Road.
Impacts on timber production zoned land in State Forests	15 ha in Glenugie State Forest.	32 ha in Glenugie State Forest.	90 ha in Glenugie and Pine Brush State Forests.	32 ha in Glenugie State Forest.
Number of residential buildings where night-time noise criteria would potentially be exceeded	225	90	35	40
Cumulative noise effects	Noise impacts would be limited to along the existing highway corridor, in areas that are already subject to road traffic noise. New noise exposure between Bom Bom and Swan Creek.	Noise effects would be split between the existing highway and the new road corridor. A new noise source would be created in areas that are currently not subject to high levels of road traffic noise. Noise reduction on the existing highway would be minimal during the day, as approximately 65% of traffic would continue to use the existing highway. Noise reduction along the existing highway at night would be substantial as a result of heavy vehicles using the Purple/B, Green/C or Red/D options.		

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	Orange/A option	Purple/B option	Green/C option	Red/D option
Impacts on indigenous heritage	Direct impacts on 3 sites of high significance.	Direct impacts on 2 sites of low significance. Indirect impacts on 1 site of moderate and 1 site of low significance.	Direct impacts on 1 site of high, 1 site of moderate and 5 sites of low significance. Indirect impacts on 1 site of moderate significance.	Direct impact on 3 sites of low significance. Indirect impacts on 2 sites of high significance and 1 site of moderate significance.
Impacts on non-indigenous heritage	Direct impacts on 4 sites of high significance. Indirect impacts on 3 sites of high significance.	Indirect impacts on 2 sites of high significance.	Indirect impacts on 2 sites of high significance.	No identified sites.
Visual	Close to existing highway and major residential centres means route is overlooked by highest concentration of people and impacts highest number of properties. Would have a lower visual impact in terms of change to the existing visual character.	Visual impacts on the local area. Follows the edges of land use units, thereby integrating with its surroundings. Provides a diverse and varied visual experience for road users.	Visual impacts high through bushland areas but severity reduced due to low population density. Moderate to high visual impacts in areas close to rural residential development. Large cuts and fills could be visually prominent. Would not provide a variety of visual experience for road users.	Southern and middle sections have low visual impact as they are in forested terrain. Approach to Clarence River crossing traverses sugar cane growing region and would result in visual fragmentation of this strong landscape unit. Limited variety of experience for road users.
Potential environmental impacts				
Impacts on endangered ecological communities	9.5 ha predominantly around Yaegl Nature Reserve.	50 ha, predominantly around Coldstream River and Pillar Valley Creek.	31 ha, predominantly around Shark Creek and Gulmarrad areas.	24 ha, predominantly around Gulmarrad and James Creek areas.
Impacts on habitat for flora and fauna	Edge effects for 1 km of high value habitat around on Yaegl Nature Reserve and SEPP 14 wetland.	10 km (102 ha) of high value habitat directly impacted around Pillar Valley, Bondi Hill and Yaegl Nature Reserve.	25 km (255 ha) of high value fauna habitat impacted, in particular around Shark Creek, Pillar Valley and Brooms Head Road.	22 km (220 ha) of high value fauna habitat impacted, in particular around Shark Creek, Pillar Valley and Brooms Head Road.
Impacts on conservation reserves (State Forests zones 1, 2 and 3A and national parks estate lands)	14.5 ha of edge effects on Glenugie State Forest associated with widening of the existing highway. Edge effects on Yaegl Nature Reserve.	12 ha of edge effects on Glenugie State Forest associated with widening of the existing highway, and severance of the north-western area of the forest. Edge effects on Yaegl Nature Reserve.	9 ha of impacts on conservation zoned land within Glenugie and Pine Brush State Forests.	7 ha of impacts on Glenugie State Forest.

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	Orange/A option	Purple/B option	Green/C option	Red/D option
Impacts on wildlife corridors	No direct impacts.	Some impacts around Pillar Valley and Shark Creek.	Impacts on identified habitat links between high ecological value areas within the Pine Brush State Forest.	
Impacts on SEPP 14 wetlands	Potential for some edge impacts on wetland in Yaegl Nature Reserve, likely to be avoidable.		Direct impacts on 3.6 ha of Shark Creek wetland.	No direct impacts on SEPP 14 wetlands
Water quality	All options cross a number of streams and waterways and therefore have the potential to impact on existing water quality.			
Air quality	Air quality impacts would be well within criteria established by DEC.	Purple/B, Green/C and Red/D options would present the least risk in terms of potential air quality impacts as these routes are generally further from residences.		
Functional and design characteristics				
Length	69 km	66 km	60 km	60 km
Maximum gradient	4.2%	4.5%	5%	5%
Design speed and speed limit	All options would meet required design standards including 110km/h vertical and horizontal design speed.			
Potential to stage construction	Construction could be staged.	Potential to stage northern and southern sections.	There are no opportunities to stage construction of these options.	
Earthworks	Large volumes of fill material would need to be imported to achieve flood immunity.	Areas of large earthworks volumes would be limited to Bondi Hill, around Tyndale.	Earthworks volumes would be high, but cut and fill volumes would be balanced.	
Soils	High potential to encounter acid sulphate soils.	Moderate potential to encounter acid sulphate soils, mainly north of Bondi Hill.	Some potential to encounter soft soils and acid sulphate soils.	
Length of option in floodplain	38 km	13 km	5 km	10 km
Maximum number of bridges required across floodplain	25	8	2	8
Maximum number of other bridges required	10	20	20	30
Average height of embankments across floodplain	2 – 3 m	1.5 – 2.5 m	2 – 3 m	2 -3 m
Project cost				
Strategic cost estimate in \$2004 (millions)	\$1,300 - \$1,400	\$950 - \$1,050	\$700 - \$800	\$700 - \$800